COPPER FLASHINGS

SECOND EDITION

♀

♀ A HANDBOOK ♀

COPPER FLASHINGS

A HANDBOOK OF DATA ON THE USE OF COPPER AS A FLASHING MATERIAL WITH STANDARD DETAILS OF CONSTRUCTION & SPECIFICATIONS FOR SHEET-COPPER WORK

♀

SECOND EDITION
FEBRUARY
1925

COPPER AND BRASS RESEARCH ASSOCIATION
25 BROADWAY, NEW YORK

NEW developments in materials and methods of construction during the last decade or so have given rise to many problems concerning proper flashing practice under various conditions. Because copper is the recognized standard material for flashings many inquiries on recommended practice have been received by this Association, and have resulted in this effort to codify what is believed to be the best practice for copper flashings.

This book not only contains the results of long and thorough study and research work on our part, but also embodies the practical experience of leading architects and roofing contractors.

Differences of opinion regarding, for instance, the use of "soft" or "hard" copper, and the necessity for expansion joints in gutter linings, were encountered and have been met by recommending what we consider to be the best practice. In the text the reader will find a full discussion of such points of difference.

It rarely happens that the early editions of books are free from errors. The Association therefore will appreciate information regarding any that may appear, as well as any comments or criticisms which will help to improve the book in its later editions.

March, 1924.

The second edition has been revised, and changed in numerous places. It should be noted, however, that these changes and revisions are in the nature of improvements in methods and descriptions of methods. The fundamental principles enumerated on page one have not been affected. Additions to the subject matter of the book have been made in one or two places.

The first edition of this book created considerable comment, and brought forth many constructive criticisms. All of these criticisms, which helped to improve the book, have been incorporated in the second edition.

February 1925.

ACKNOWLEDGMENT TO FIRST EDITION

The Association acknowledges with thanks the assistance of Thomas Nolan, F. A. I. A., Professor of Architectural Construction, University of Pennsylvania, for editorial criticism and other suggestions regarding the contents of this book. Acknowledgment for invaluable cooperation is also made to

American Bridge Company
American Face Brick Association
American Institute of Architects, Structural Service Committee
Associated Tile Manufacturers
Atlantic Terra Cotta Company
Atlas Roofing Company
Grosvenor Atterbury, Architect
Elliot C. Brown Co., Builders
Carrère and Hastings, Architects
Wm. F. Clark Co., Roofers
Common Brick Manufacturers' Association of America
Crawfordsville Foundry Co.
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Guilbert and Beteller, Architects
Wallace R. Harris, International Trade Press, Inc.
Hollow Building Tile Association
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Otto Walters, Concrete Roofing Tile
Warren & Wetmore, Architects
Wells Construction Co., Builders
Chas. T. Wills, Inc., Builders
Ira H. Woolson, Consulting Engineer

And to Many Others.

ACKNOWLEDGMENT TO SECOND EDITION

Space does not permit mention of the names of all who have assisted in revising this book. To those whose interest in the general subject of improvement in the art of flashing prompted them to offer to us the benefit of their knowledge and experience, the Association extends its sincere thanks.

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["FIG." refers to the Standard Details and Special Notes, pages 2 to 27; "SPEC." refers to the Standard Specifications, pages 29 to 42.]

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INDEXED TABLE OF CONTENTS (Continued)

PART ONE

Standard Details of Construction and Specifications for Sheet-Copper Work

TEN RULES FOR APPLYING COPPER FLASHINGS

RULE 1. **Use 16-ounce soft (Roofing Temper) copper only.**
- (a) Do not use hard (Cornice Temper) copper except for cornice work.
- (b) Do not use lighter than 16-ounce copper.

RULE 2. **Prepare the laying surface carefully and see that it is smooth and even.**
- (a) All flashings, gutter-linings, etc., should be laid on rosin-sized paper or asbestos felt.
- (b) Sheathing boards should be ship-lap, tongued-and-grooved, or splined.
- (c) All nail heads should be set.

RULE 3. **Avoid sharp bends in copper sheets.**
- (a) Do not crease the sheets or bend them more than 90°.
- (b) Bend the sheets as little as possible before laying.

RULE 4. **Allow for the movement of copper at intersections of roof planes by large loose-locked joints.**
- (a) Never carry a copper sheet over an angle more than 3 or 4 inches.
- (b) Break the sheet and lock it to the adjoining one by means of a loose- or double-locked joint. This allows room for expansion and contraction.

RULE 5. **Never nail copper sheets. Use cleats.**
- (a) By "sheet" is meant any piece over 12 inches wide.
- (b) Use two-nail cleats 1½ inches wide and place them not more than 12 inches apart.

RULE 6. **Use copper nails only—never iron or steel—for fastening strips and cleats.**
- (a) Flat-head, wire nails are the best.
- (b) Strip copper should be nailed along one edge only.
- (c) Nails should be spaced 4 inches maximum.

RULE 7. **Make full size joints and seams.**
- (a) Standing Seams at least 1-inch finished.
- (b) Flat Seams (locked) at least ½-inch finished.
- (c) Lapped Seams at least 1-inch finished.
- (d) Double or copper-locked Seams at least ½-inch finished.

RULE 8. **Tin carefully and thoroughly.**
- (a) Use heavy tinning-coppers.
- (b) Use enough tin to cover all the surface.

RULE 9. **Use rosin as a flux rather than acid.**
- (a) If acid is used see that it is properly and **thoroughly** killed.

RULE 10. **Plenty of solder, well-flowed over, makes strong seams.**
- (a) Use the best half-and-half solder and lots of it.
- (b) Heat the seam thoroughly.
- (c) Heavy, hot coppers are best for this.

GENERAL NOTES—ALL DRAWINGS

1. **The drawings** are intended to show details for every trade involved in any particular type of construction, and are suitable for use by the drafting room in designing details.

2. **Distortion.** The distortion of the details will be apparent at first glance. This has been done for emphasis so that the treatment of the copper will be clear.

3. **Arrangement.** The cuts have been arranged, as nearly as possible, to show details of flashing of different kinds for various types of construction.

4. **Notes and Legend. The notes on the drawings have been simplified as much as possible to avoid too much lettering. For this reason the word "shingles" refers to all small-piece roofings, such as slate, shingles, shingle tile, etc., except copper shingles.**

The expressions "cap" and "counter-"flashings are used as synonymous terms throughout.

5. **Exposed Edges.** We recommend the practice shown of folding all exposed or loose edges of flashings back. The return is about ½ inch and may be done either in the shop or on the job. It stiffens the edge considerably and prevents lifting by the wind and clogging with snow and ice and attendant troubles. It also makes a neat finish. The edges are flattened tightly together. In the drawings they have been shown slightly open for clearness.

6. **Paper. The use of building paper under all flashings is recommended. To avoid confusion it has been omitted from the drawings.**

7. **Patented Devices.** Practically no details involving patented roofing-devices or drains have been shown. There are many of these on the market, most of which are practicable. We recommend the use of those devices which use eighteen-ounce or heavier copper, or cast brass, because they represent a quality product, the result of the best workmanship by reputable manufacturers.

8. **Copper Shingles.** Flashings for copper shingles have not been shown. They are, in almost every case, of special design, and are supplied by the manufacturer of the shingles.

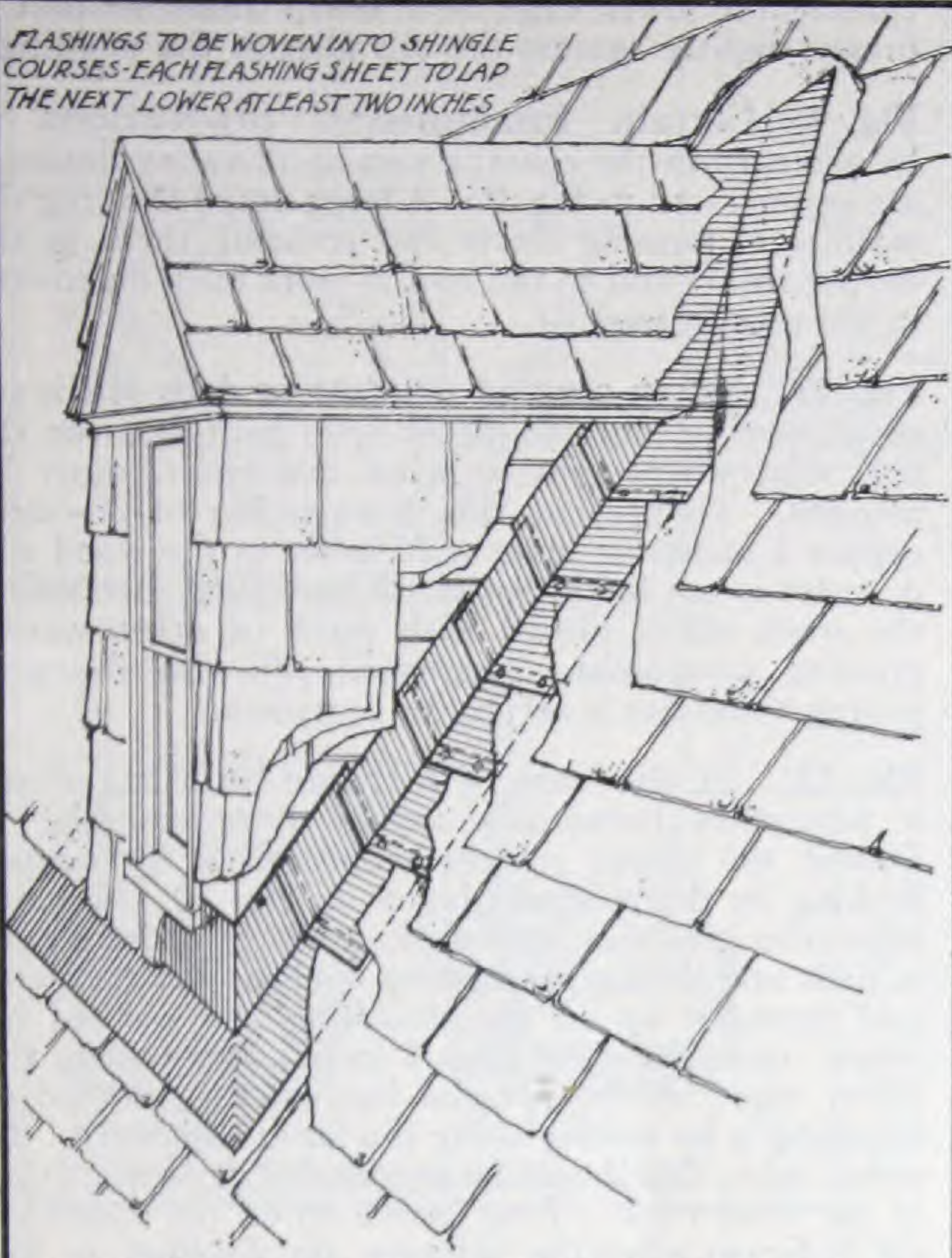
SPECIAL NOTES

Fig. 1. The flashing for a dormer window covered with shingles and on a shingle roof is shown in Fig. 1. Flashing sheets should be so placed that each sheet will lap the one below at least two inches and be separated by one shingle thickness. Sheets should extend up on the walls at least four inches and be nailed near the top with one or two copper nails as shown. Flashings will not be visible on the roof or walls except on the roof below the front wall where they lap over the top of the shingles four inches. Care should be taken to see that each sheet extends above the shingle on which it rests so it may be nailed without puncturing the shingle.

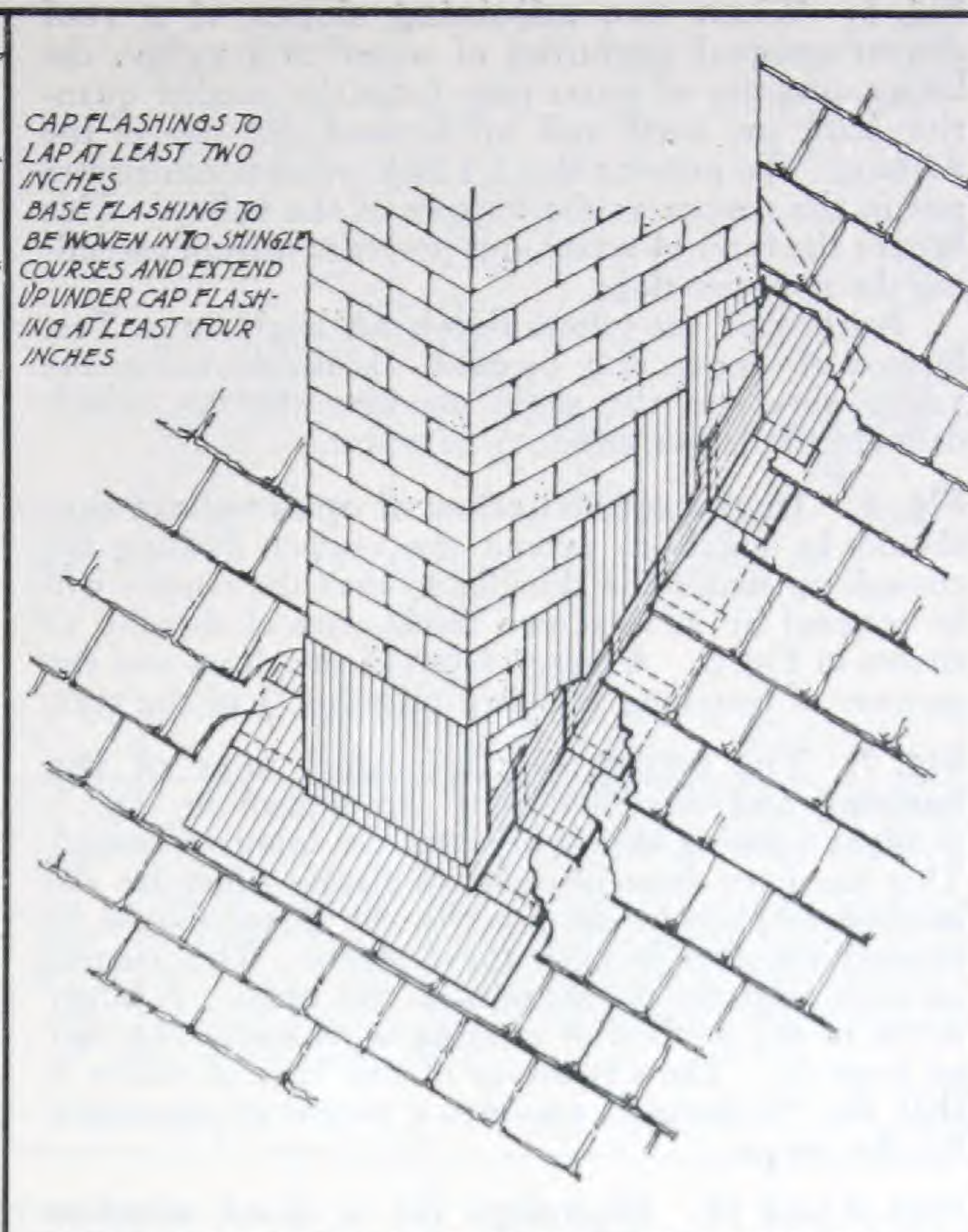
Fig. 2. A chimney on the slope of a shingle roof is shown in Fig. 2. The base flashings on the roof are formed and fastened as in Fig. 1. This method is better than that shown in Fig. 4. Cap flashings should be built in as the chimney is constructed and stepped as required by the slope of the roof. They should be built into the joints of the brick work about two inches. Each sheet should lap outside the one below at least two or three inches.

Fig. 3. A cricket, or saddle, should be formed back of all chimneys to throw the water to either side of the chimney as shown in Fig. 3. It is generally formed of wood, sloped enough to shed water, and covered with copper, thus forming a base flashing, which is turned up on the brick work, and cap flashed as described in Fig. 2.

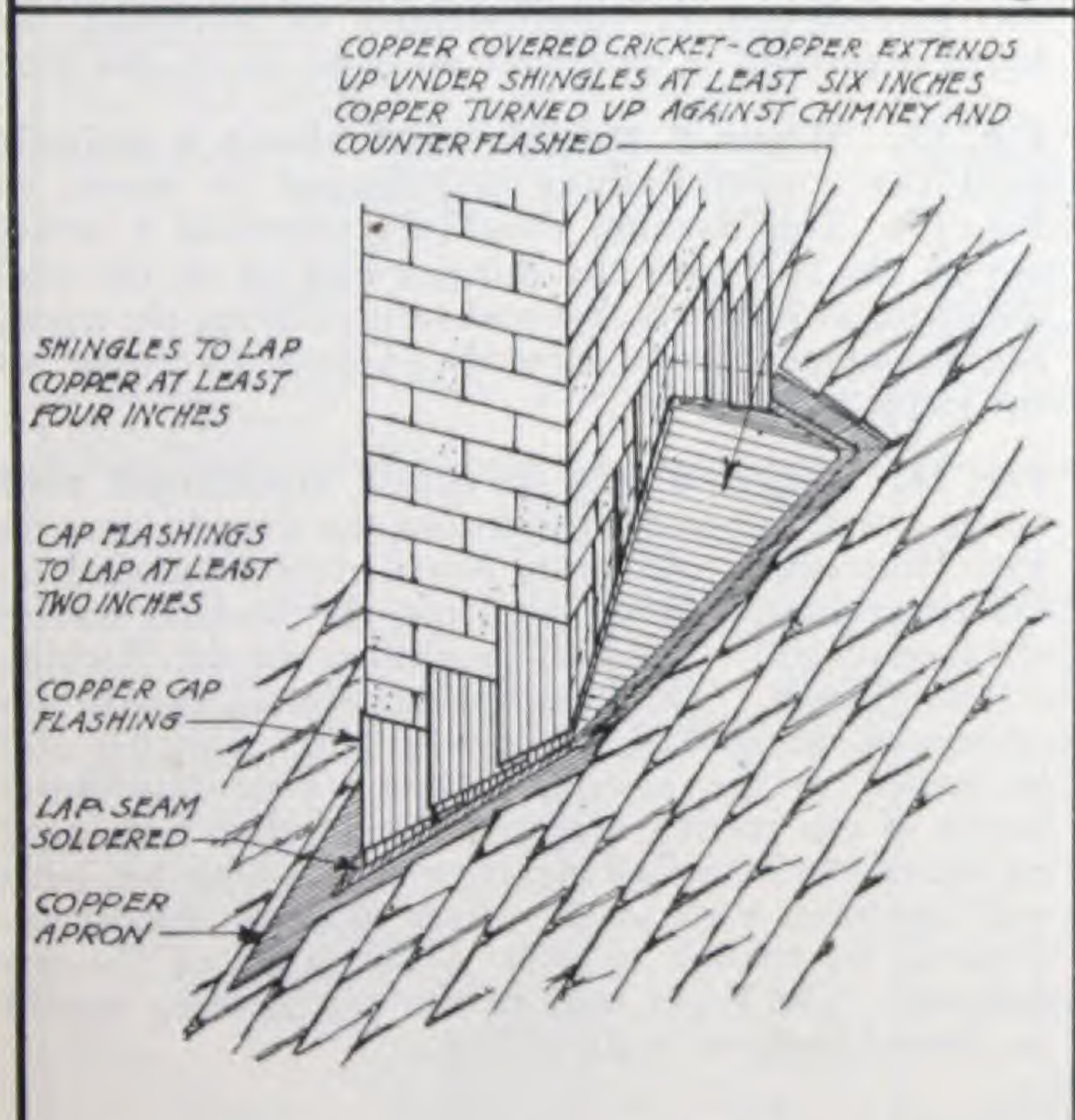
Fig. 4. The method of flashing a chimney on the ridge of a shingle roof is shown in Fig. 4. The base flashing is here shown in one large sheet but it may be made in small sheets as described in Fig. 2, The small-piece method is recommended. The cap flashing is formed as described in Figs. 2 and 3.



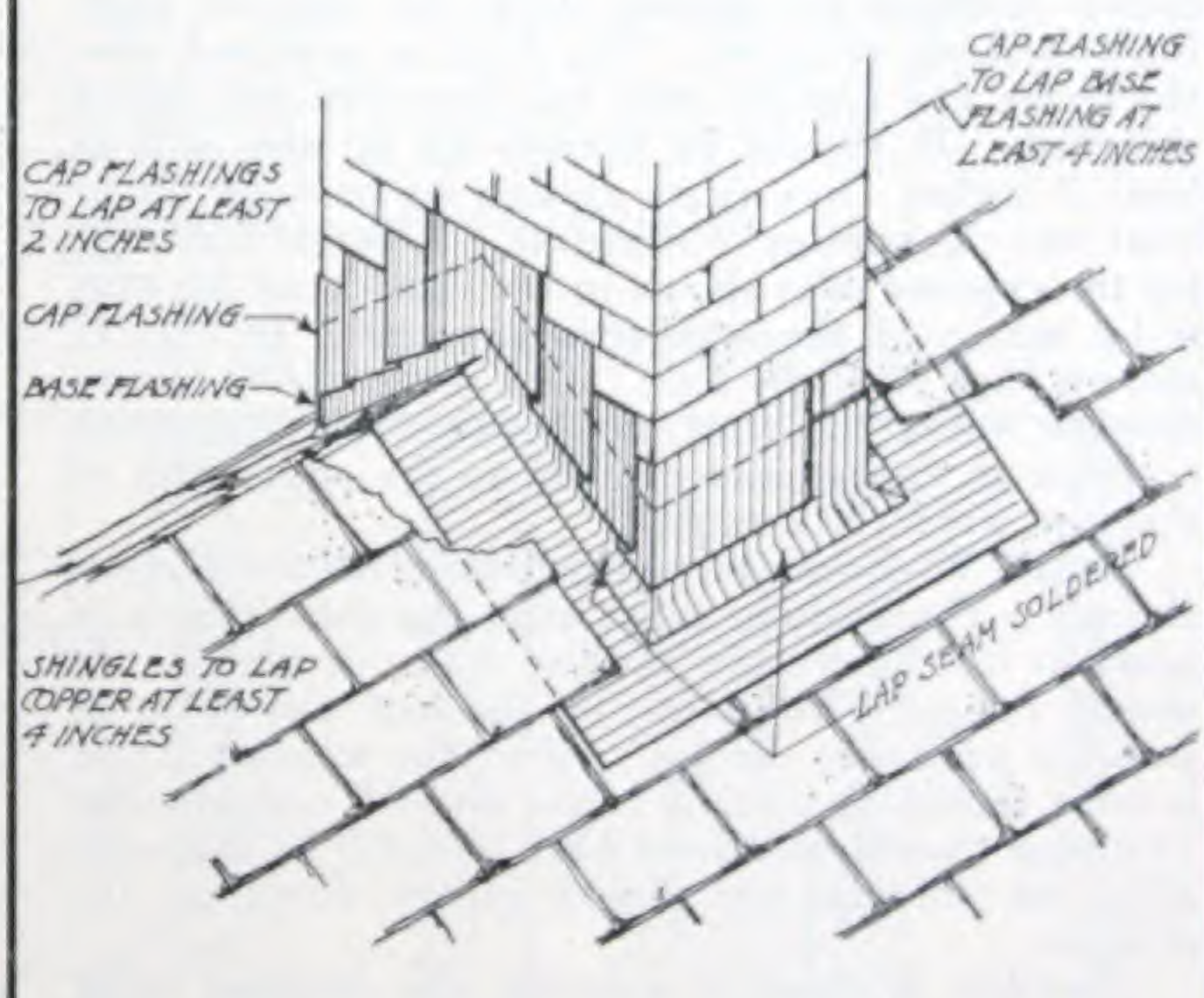
BUILT IN BASE FLASHING FOR DORMER WINDOW ON SHINGLE ROOF (1)



BUILT IN BASE FLASHING FOR CHIMNEY ON SLOPE OF SHINGLE ROOF (2)



FLASHING FOR CHIMNEY ON SLOPE OF SHINGLE ROOF (3)



FLASHING FOR CHIMNEY ON RIDGE OF SHINGLE ROOF (4)

Fig. 5. When two adjoining slopes of a roof deliver unequal quantities of water to a valley, the larger quantity of water may force the smaller quantity back on itself and up beyond the top of the flashing. To prevent this a 1 inch crimp is sometimes put in the copper at the bottom of the valley. This breaks the force of water and prevents it from ascending the opposite slope.

Instead of the crimp shown an angle, or a Tee, formed of copper, may be used. It is soldered to the valley sheet on the slope opposite the one which delivers the larger quantity of water.

Fig. 6. In the construction of open valleys care should be taken to extend the copper flashing far enough up under the shingles so that the copper will be covered by at least two thicknesses of shingles as shown in Fig. 6. A larger detail of the cleats and the manner of fastening is shown on page 51 of the text.

Fig. 7. The return on the upper edge of the flashing and the "fold-over" are shown in Fig. 7. A slight opening shows between the layers of metal. This has been done in order to clearly illustrate the method employed. In practice the metal should be pressed together in both these places. This insures an even ridge for the shingles to rest upon. A larger detail of the method of cleating is shown in the text on page 51. The advantage of this type of valley is that the "fold-over" provides a means of expansion for the copper.

Figs. 8 and 10. Flashings for a wood window frame in a stud wall are shown in Figs. 8 and 10.

Fig. 8 shows two methods of flashing the window head. The left-hand drawing shows the edge of the flashing covered by the molding. At the right it is shown fastened by nailing along the exposed edge. Both methods are good. The flashing is placed after the frame and outside trim has been set but before shingling. It should be carried up on the wall at least 3 inches (but must always be covered by at least two thicknesses of shingles). A better fastening for the exposed edge shown in the right-hand drawing is by means of the edge-strip illustrated in Fig. 12 and on page 54 of the text. This is expecially recommended when the trim has considerable projection or when an uneven row of nails on the upper edge of the trim would be unsightly.

Figure 10 shows the method employed for flashing the sill. The flashing is set after the sheathing is in position but before the window frame is placed. It should extend 4 inches out on the roof and as far as possible up under the sill. After the window frame is set it should be secured to the sill with copper nails. The edge should be turned back on itself ½ inch and after the shingles are placed turned down on the shingles.

Another method of securing this flashing is by nailing along the upper edge under the shingles and turning the lower edge at a sharp angle so that it presses tightly against the top fillet of the molding.

Fig. 9. Certain fundamental precautions to be observed in the construction of all valley flashings are enumerated in Fig. 9. A large detail showing the manner of forming cleats and securing them to the copper sheets and to the roof is more fully illustrated in the text on page 51.

Fig. 11. When a wood window or door sill is set on a stone or concrete sill an open joint between the two sills, where rain or wind can enter, must be avoided. To prevent this a water-bar of 20-ounce copper 2 inches or more wide is set in the wood sill. A reglet is cut in the stone sill and filled just before the wood sill is placed with pitch or other waterproofing compound. The wood sill with the projecting water-bar is set in this compound.

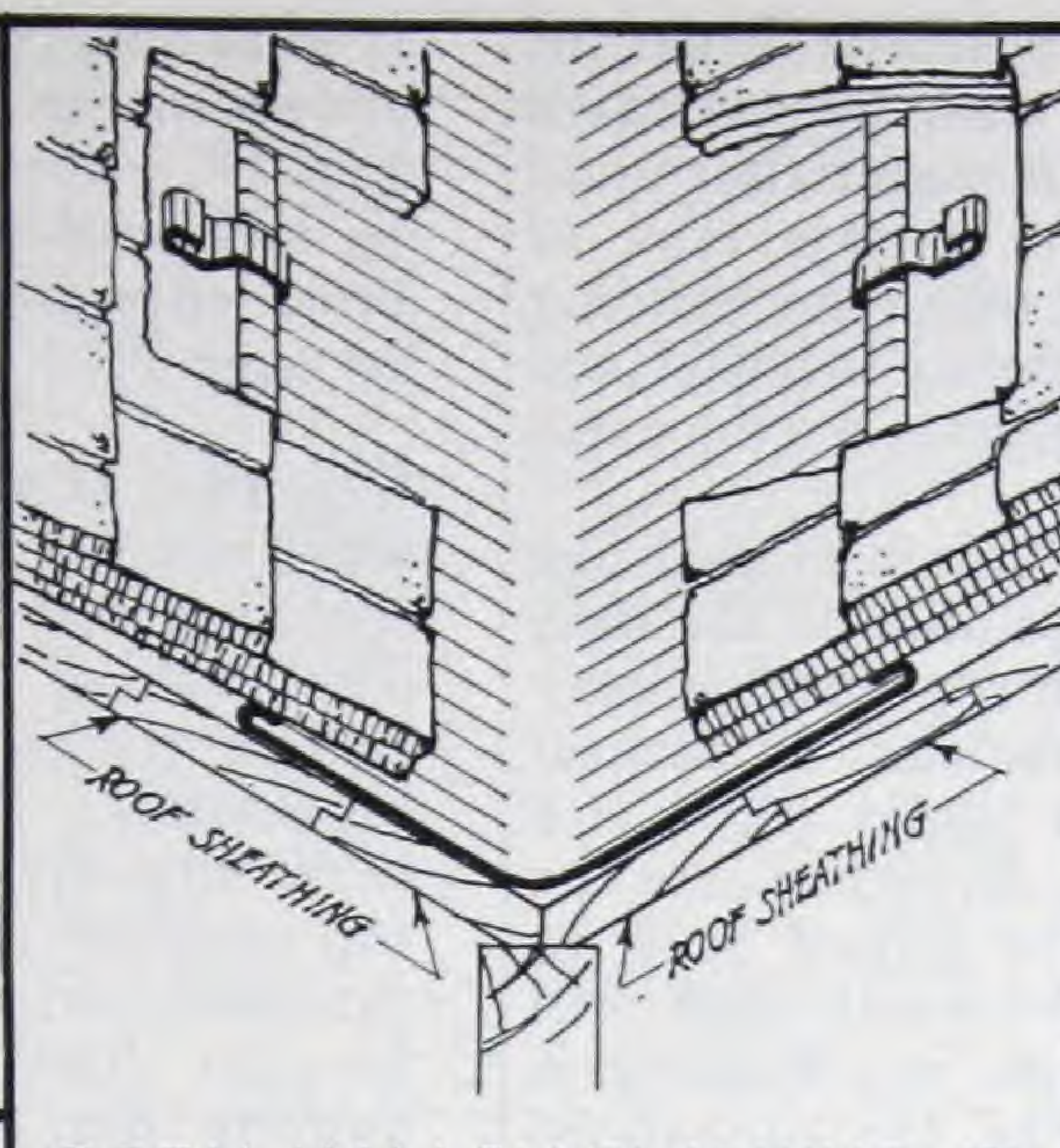
Fig. 12. At the base of a frame building where a projection (sometimes called a water-table) is formed the upper surface is protected by copper flashing in the manner shown in Fig. 12. A brass edge-strip is first secured to the wood by brass screws or nails and the copper flashing hooked over this strip and extended up on the sheathing and secured by copper nails not more than 8 inches apart along the upper edge. A cheaper and less efficient method of fastening is by nailing along the lower edge only. In either case a drip should be provided to prevent rotting of the wood work. Four inches up on the sheathing are sufficient when the shingles are doubled at the bottom of the wall but more is needed if shingles are but single course and the copper must be covered by the second course. The manner of applying the brass edge-strip is described on page 54 of the text.

Fig. 13. When a shingle roof abuts a shingle wall the copper flashing is arranged as shown in Fig. 13. This flashing should be extended 4 inches out on the roof over the shingles and up on the wall sheathing at least 4 inches and secured along the upper edge by copper nails. Note the ½-inch "fold-over" of the lower edge.

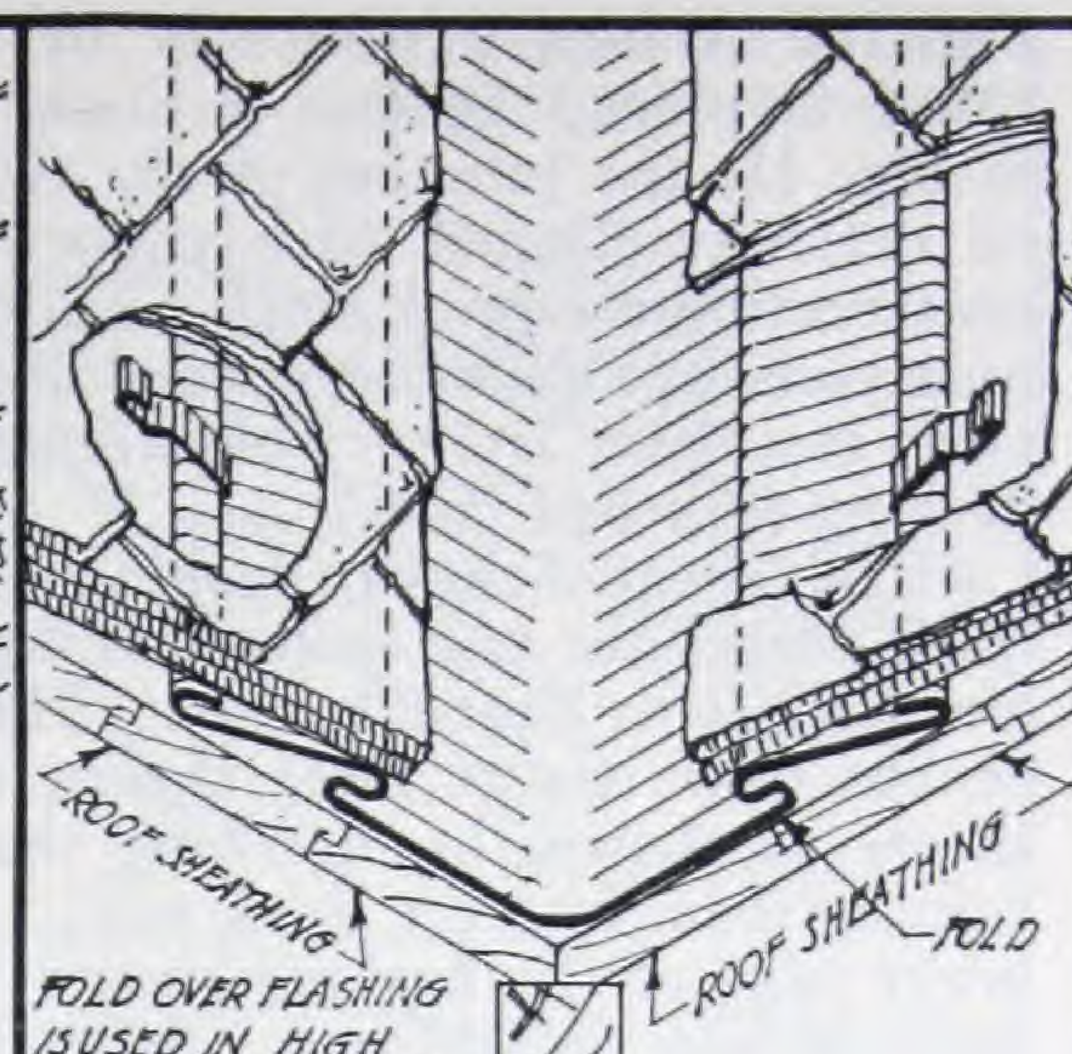
Fig. 14. When a felt or other laminated roof abuts a wall covered with stucco the detail shown in Fig. 14 is used. An extra board may be placed on the sheathing as shown to bring the flashing out to the face stucco. The lath should lap the cap flashing at least 1 inch. The base flashing should extend out on top of the roofing material at least 4 inches and be nailed to the roofing boards. Two additional layers of the roofing material should then be placed on top of the base flashing after the flashing has been well swabbed with pitch. Base flashing should extend up far enough to allow a 4-inch lap of the cap flashing. The lower edge of the cap flashing should be turned back on itself ½ inch.

WHEN ROOF SLOPES DO NOT HAVE THE SAME PITCH OR WHEN ONE ROOF DISCHARGES MORE WATER THAN THE OTHER THE CRIMP IS PLACED IN THE VALLEY TO BREAK THE FORCE OF THE DESCENDING WATER AND PREVENT THE WATER FROM ONE ROOF BEING FORCED ABOVE THE TOP OF THE FLASHING ON THE OPPOSITE SLOPE

CRIMP USED IN OPEN VALLEYS (5)

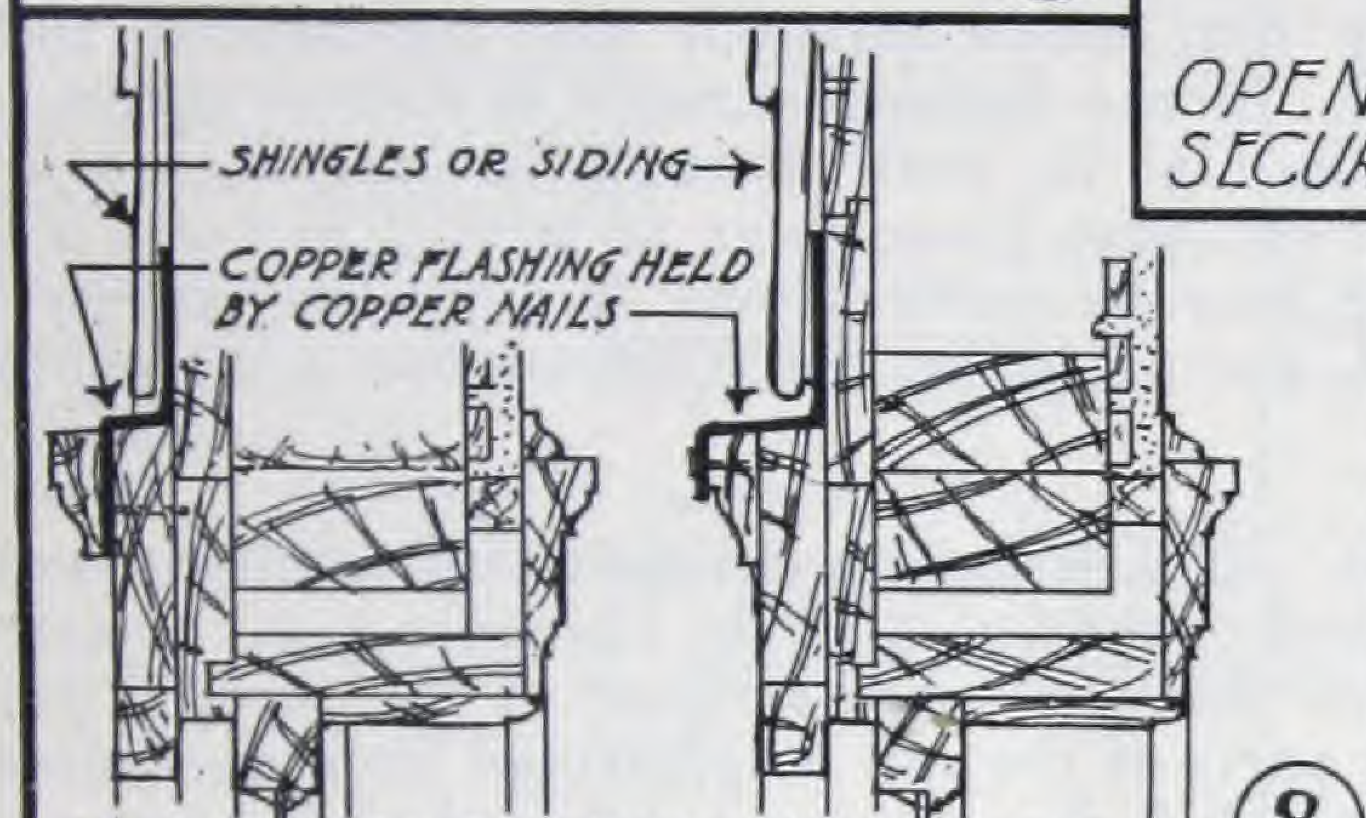


OPEN VALLEY FLASHING SECURED BY CLEATS (6)



FOLD OVER FLASHING IS USED IN HIGH GRADE WORK AND IS MADE IN 16 AND 18 INCH WIDTHS

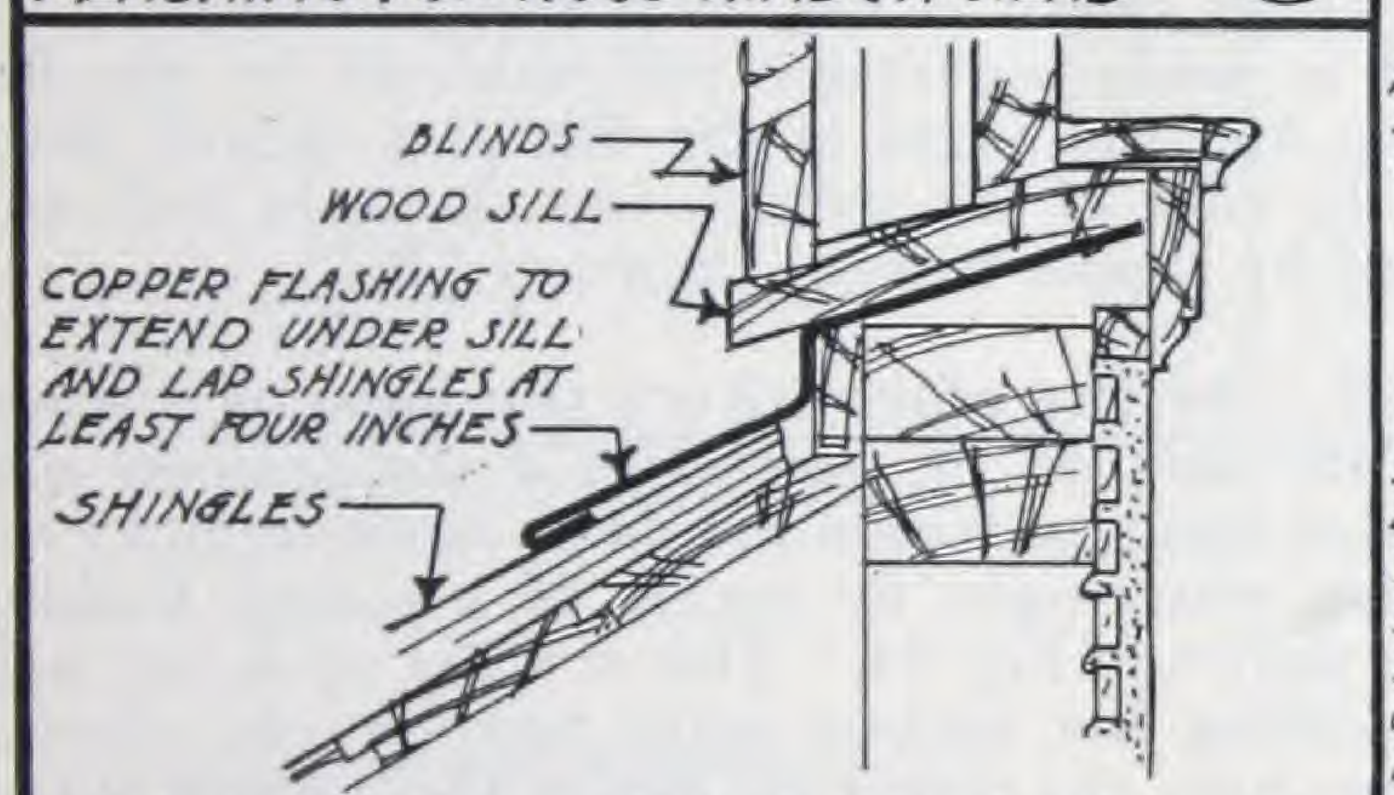
"FOLD OVER" VALLEY FLASHING (7)



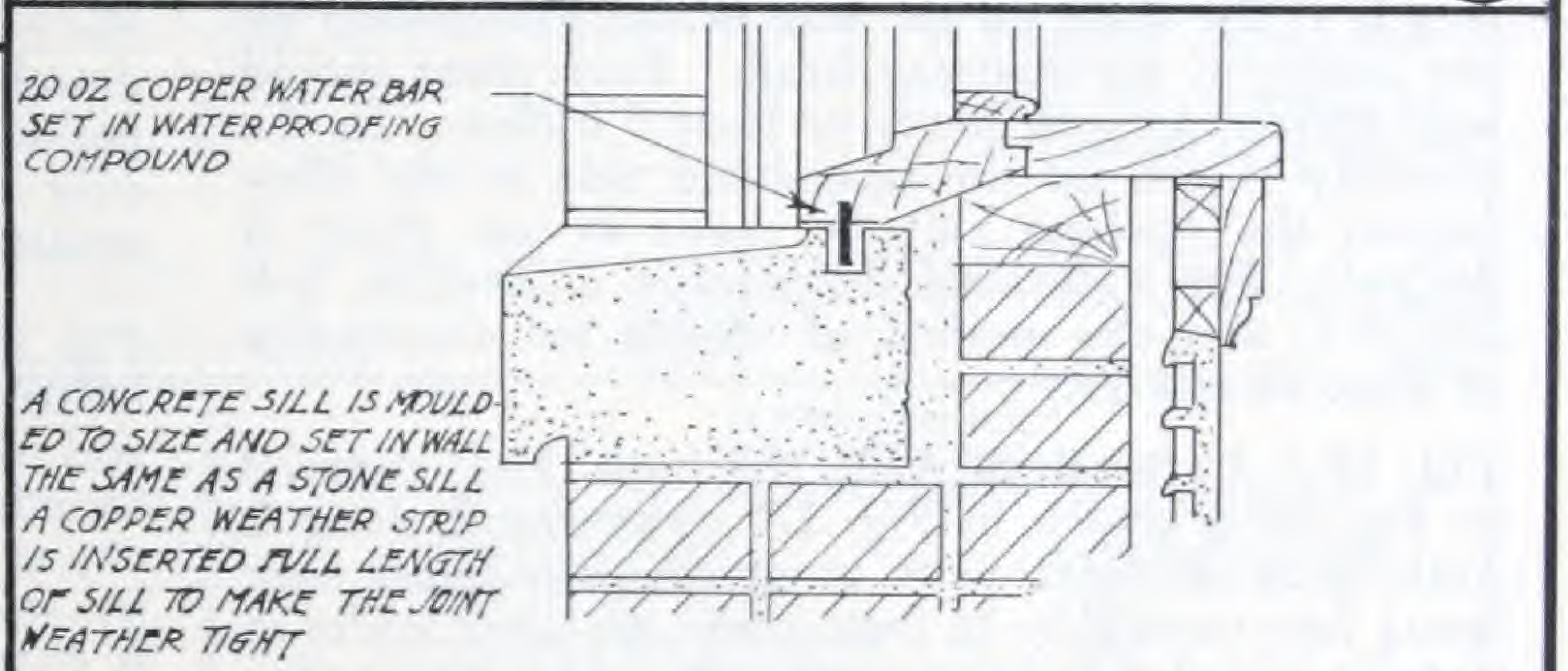
FLASHING FOR WOOD WINDOW HEAD (8)

DISTANCE FROM EDGE OF SHINGLES TO BOTTOM OF VALLEY SHOULD BE NOT LESS THAN TWO INCHES AT NARROW PART WITH ONE HALF INCH IN EIGHT FEET INCREASE TOWARD GUTTER.
FLASHINGS TO BE SECURED BY SOFT COPPER CLEATS ONE AND A HALF INCHES WIDE AND ABOUT THREE INCHES LONG EACH FASTENED TO ROOF WITH TWO COPPER NAILS AND END TURNED OVER NAIL HEADS.
CLEATS SPACED EIGHT TO TEN INCHES ON CENTRES AND LOCKED TO SHEETS BY HALF INCH FLAT LOCK.

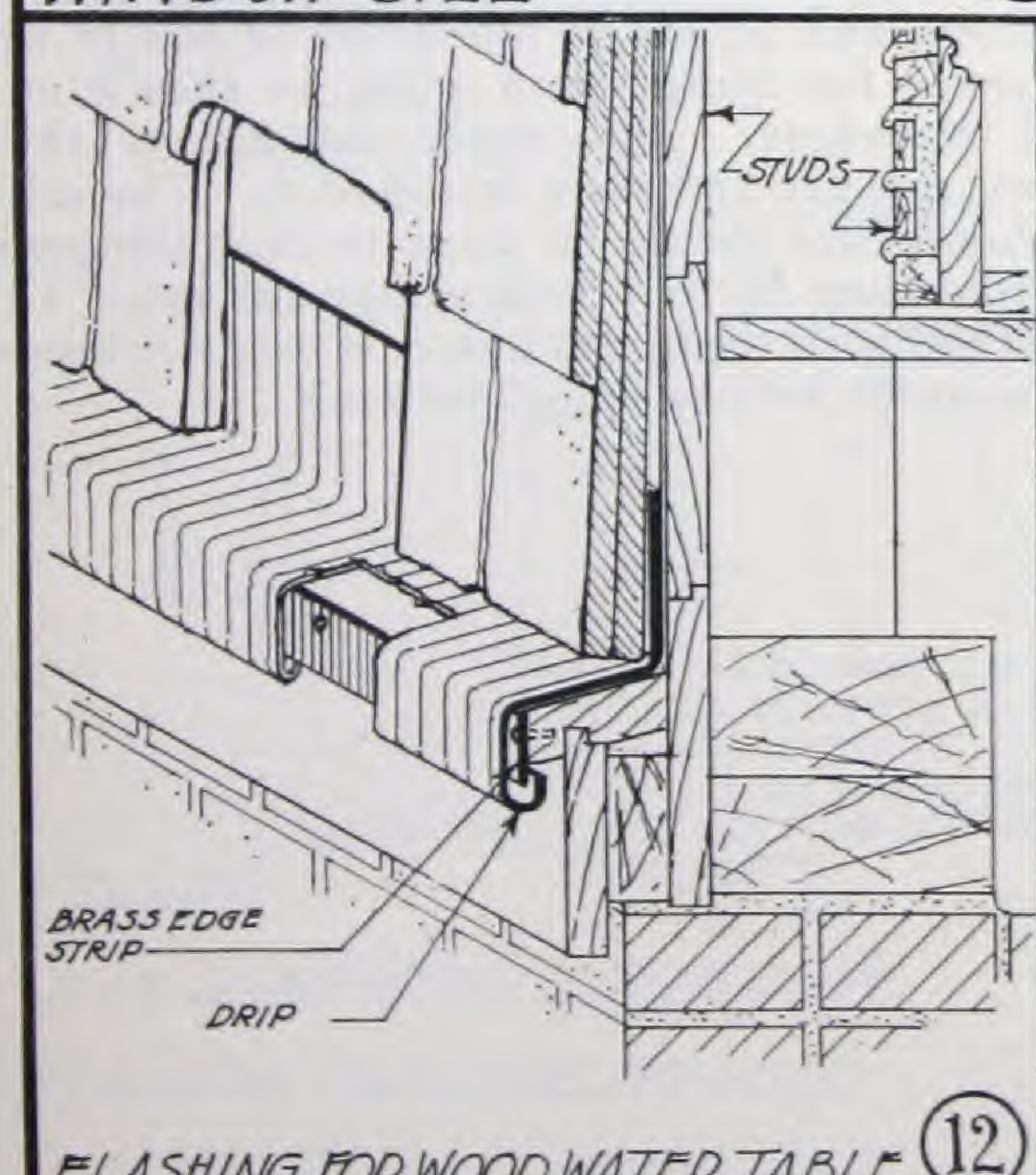
NOTES ON OPEN VALLEY FLASHINGS (9)



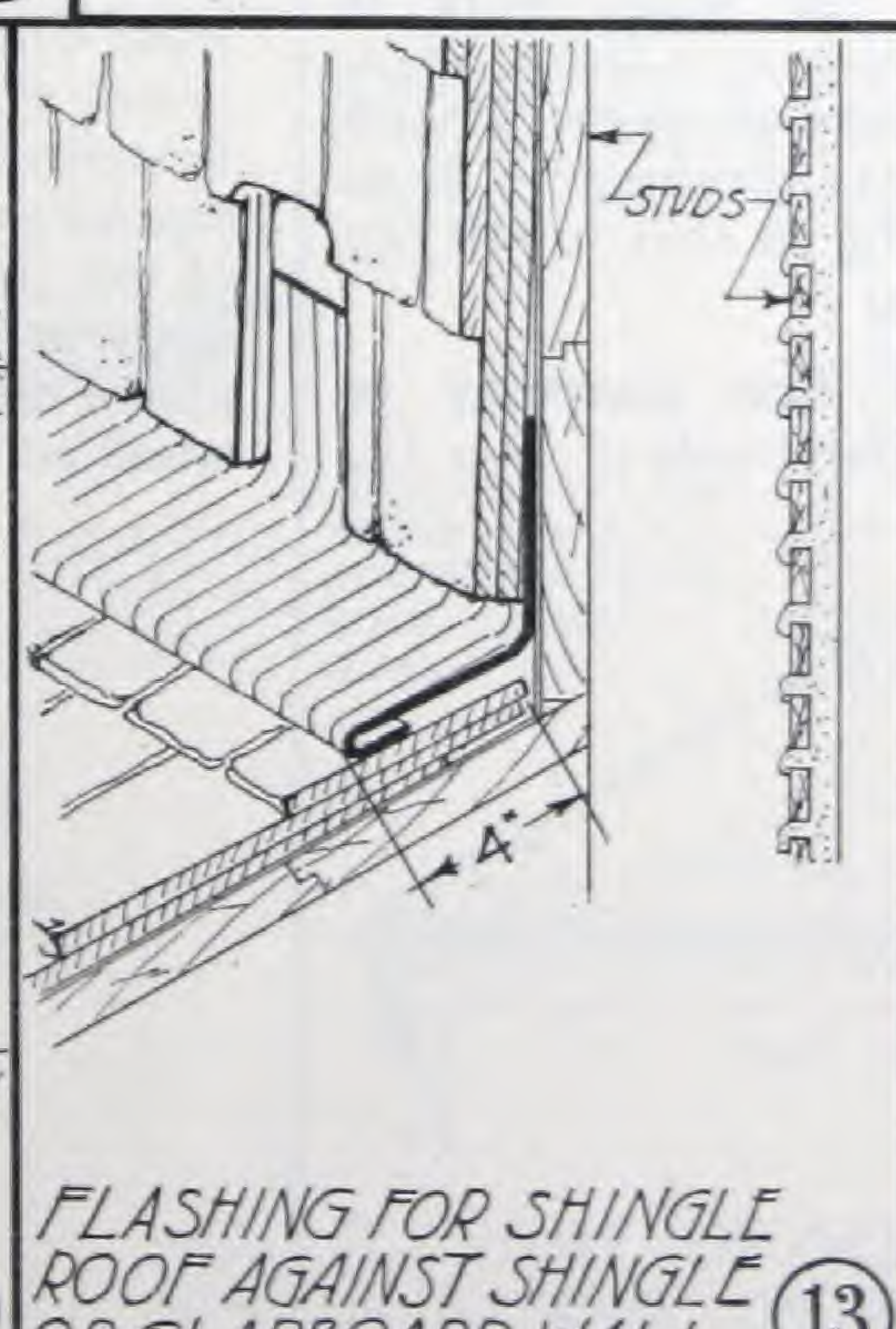
FLASHING FOR DORMER WINDOW SILL (10)



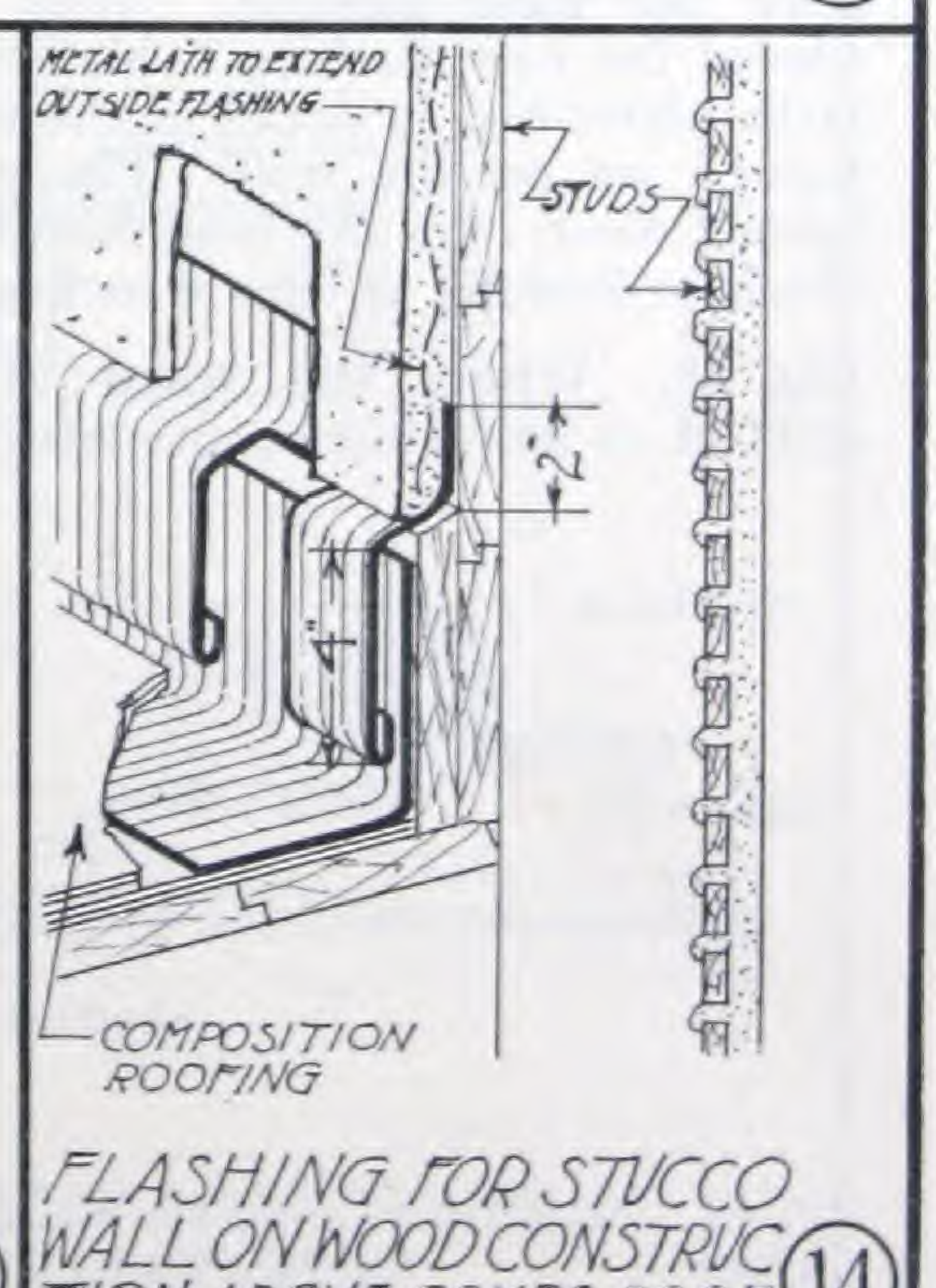
COPPER WATER BAR FOR STONE WINDOW SILL (11)



FLASHING FOR WOOD WATER TABLE (12)



FLASHING FOR SHINGLE ROOF AGAINST SHINGLE OR CLAPBOARD WALL (13)



FLASHING FOR STUCCO WALL ON WOOD CONSTRUCTION ABOVE COMPO ROOF (14)

Fig. 15. When a doorway or window built of wood is placed against a brick wall, as indicated in Fig. 15, the junction of the two materials should be carefully flashed with copper. In this type of construction the brick work is built up as the building progresses but the molded wood doorway is not placed until sometime later. This necessitates a two piece flashing (cap and base.).

Each sheet of the cap flashing is built in as the brick work progresses and each sheet laps outside the next lower sheet at least 2 inches. The cap flashing may be cut from one or more sheets, instead of several sheets as shown, by notching the upper edges and turning them into the brick work. In either case the lower edge of the flashing should be turned back on itself ½ inch for stiffness. After the wood work is in place and the base flashing set the cap flashing is turned down over the base flashing far enough to lap the base flashing at least 4 inches. For a detail of Section A-A and description of the method of placing this flashing see Fig. 17.

Fig. 16. A wood doorway against a stucco wall is shown in Fig. 16. In this case the wood trim of the doorway will be in place before the stucco or shingles are applied. The cap and base flashings may, therefore, be made in one piece or two, as desired. If the doorway has a segmental head as shown on the left-hand side two-piece construction only may be used, owing to the curved-shape doorway. The horizontal length of the sheet on the wall is also determined by the radius of the doorway head. Each sheet should lap outside the next lower at least 2 inches. In the doorway shown on the right-hand side of the illustration the flashing may be made in one sheet, if desired. For a detailed description of Section B-B and C-C and the method of setting see description of Figs. 18 and 19.

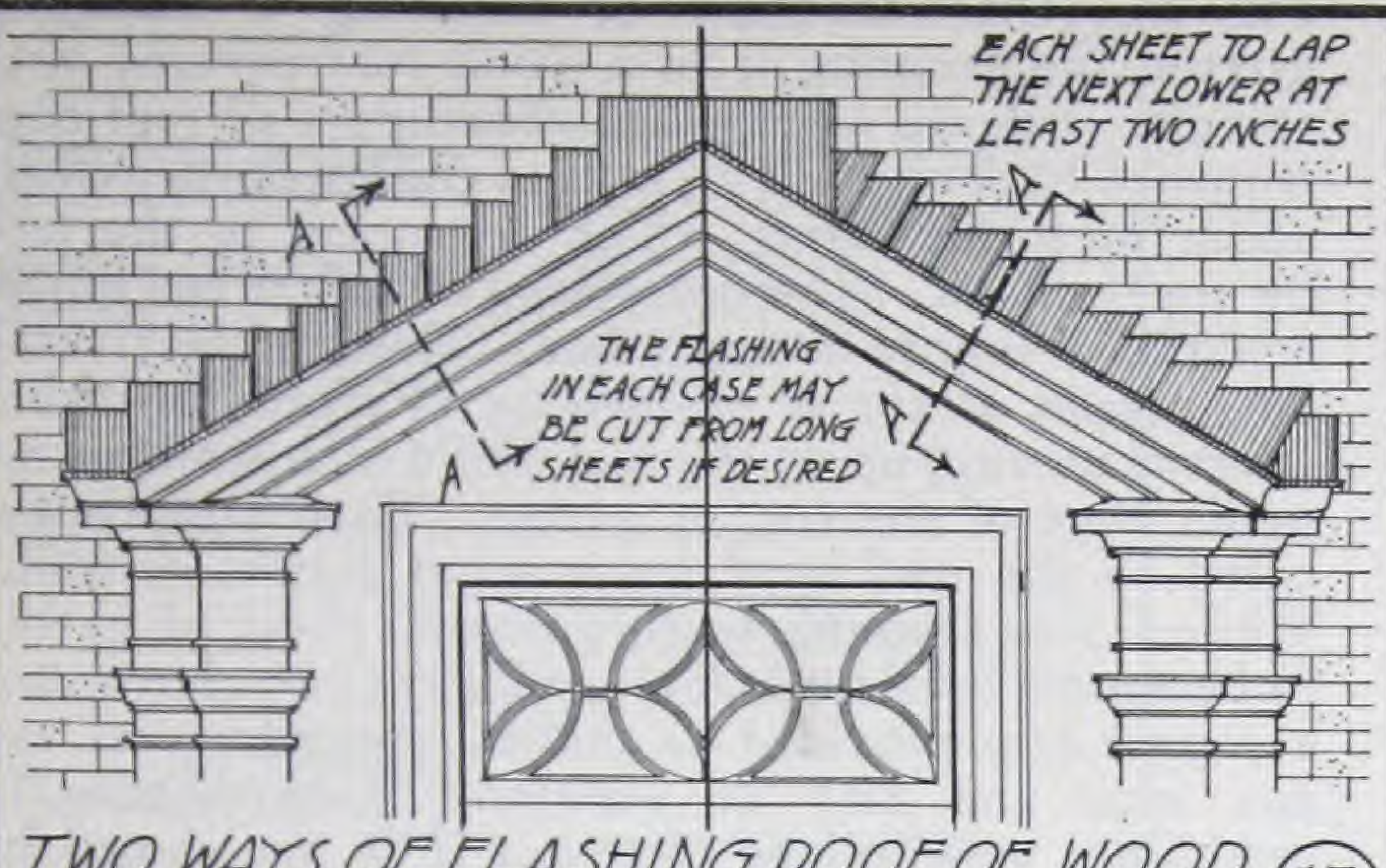
Fig. 17. A Section A-A through the cornice in Fig. 15 is shown in Fig. 17. The cap flashing is built in as the brick work progresses, the upper edge being first turned up ½ inch (although some prefer to turn it completely back on itself). The lower edge is also turned back on itself and later turned down over the base flashing. After the wood work is placed the base flashing is hooked over a brass edge-strip (described in detail in the text on page 54) and turned up on the wall. The cap flashing is then turned down over the base flashing so that it will lap the base flashing at least 4 inches.

Fig. 18. When the head of the doorway is curved as indicated by the left-hand side of Fig. 16, it is necessary to make the flashing in two pieces as shown in Fig. 18, instead of in one piece as shown in Fig. 19. The lap of the two pieces should be at least ½ inch well-soldered. The method of applying the brass edge-strip is more fully described in the text on page 54.

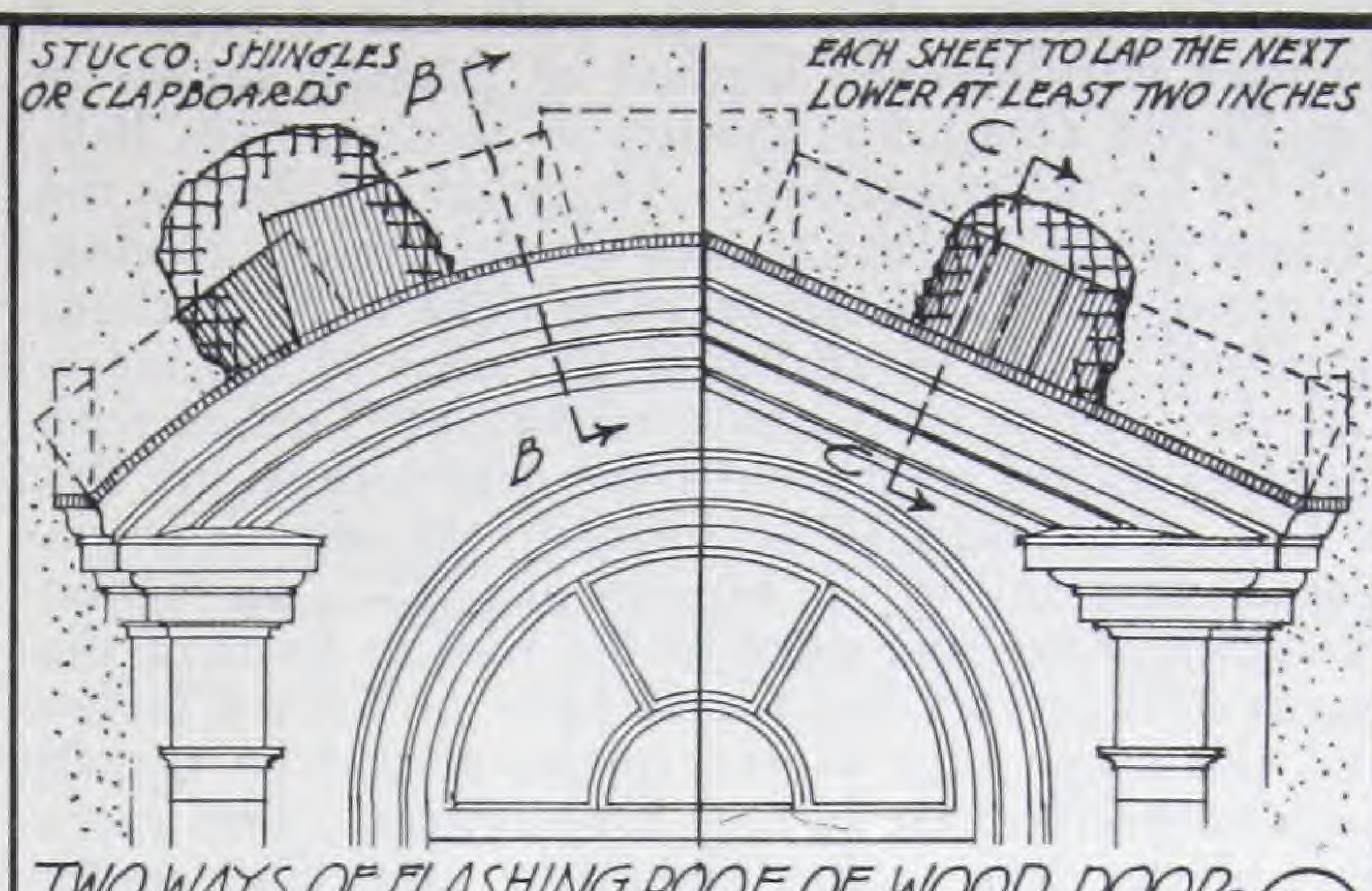
Fig. 19. If a wood doorway is set against a wood wall covered with stucco as shown in Fig. 16, the moldings will be in place before the stucco is applied. The flashing may be made in one piece instead of two as shown in Fig. 17 (except when the head is segmental). The flashing is first hooked over a brass edge-strip nailed or screwed to the face of the top molding (described in the text on page 54) and extended up on wall at least 4 inches. The lath is brought down outside and a little in front of the flashing but nailed above it and the stucco then applied. If the flashing is made in several sheets as shown in Fig. 16, each sheet of flashing should lap outside the next lower sheet at least 2 inches. The flashing may be made in one or more long sheets if desired, except where the doorway has a segmental head.

Fig. 20. If a wood or composition column-cap is exposed to the action of the elements, good practice demands that the upper surfaces of the exposed projecting parts of the cap be protected from dampness. To accomplish this the top is covered with copper in the manner shown in Fig. 20. The portion over the dowel is made separately and soldered to the flat portion and the edges of the flat part turned down over the edge of the column cap about ½ inch and secured by copper nails as shown at "B."

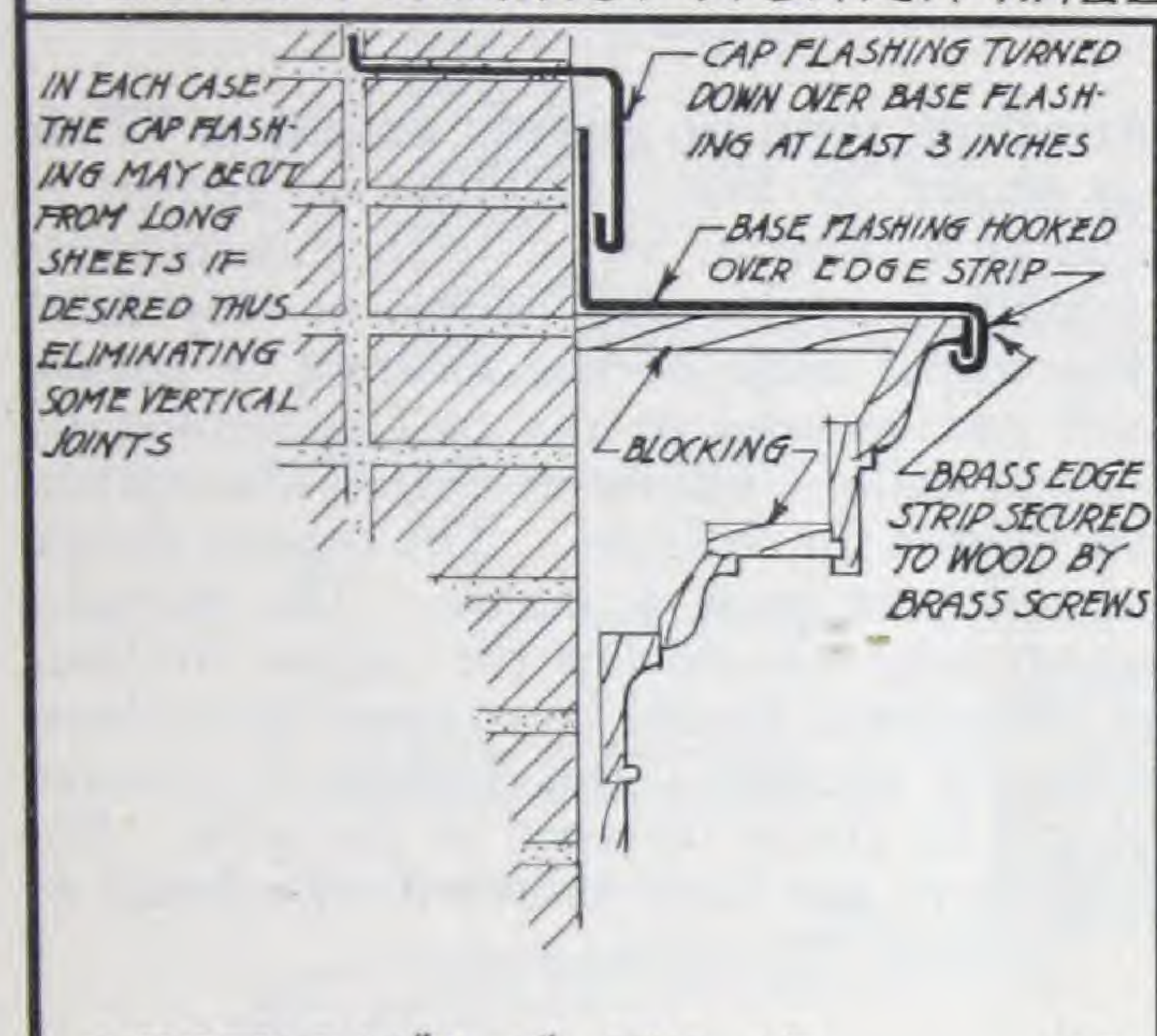
Fig. 21. At the place where the base of a wood column rests on or penetrates a composition roof laid over wood, provision should be made to make the junction water-tight by means of a copper flashing cap as shown in Fig. 21. This is made up in one unit by soldering the various parts together and placing it either over the dowel on top of the column below or over a projection raised on the deck for this purpose. The copper should extend out on the roof at least 6 inches and be set in the layers of felt in the usual manner for composition roofs as shown and described elsewhere. The upper column is then placed over this cap and rests on top of it. The sides of the column base should be made to clear the composition roof from ½ to 1 inch to prevent rot. The above method with slight variations is used for round wood columns as well as square columns.



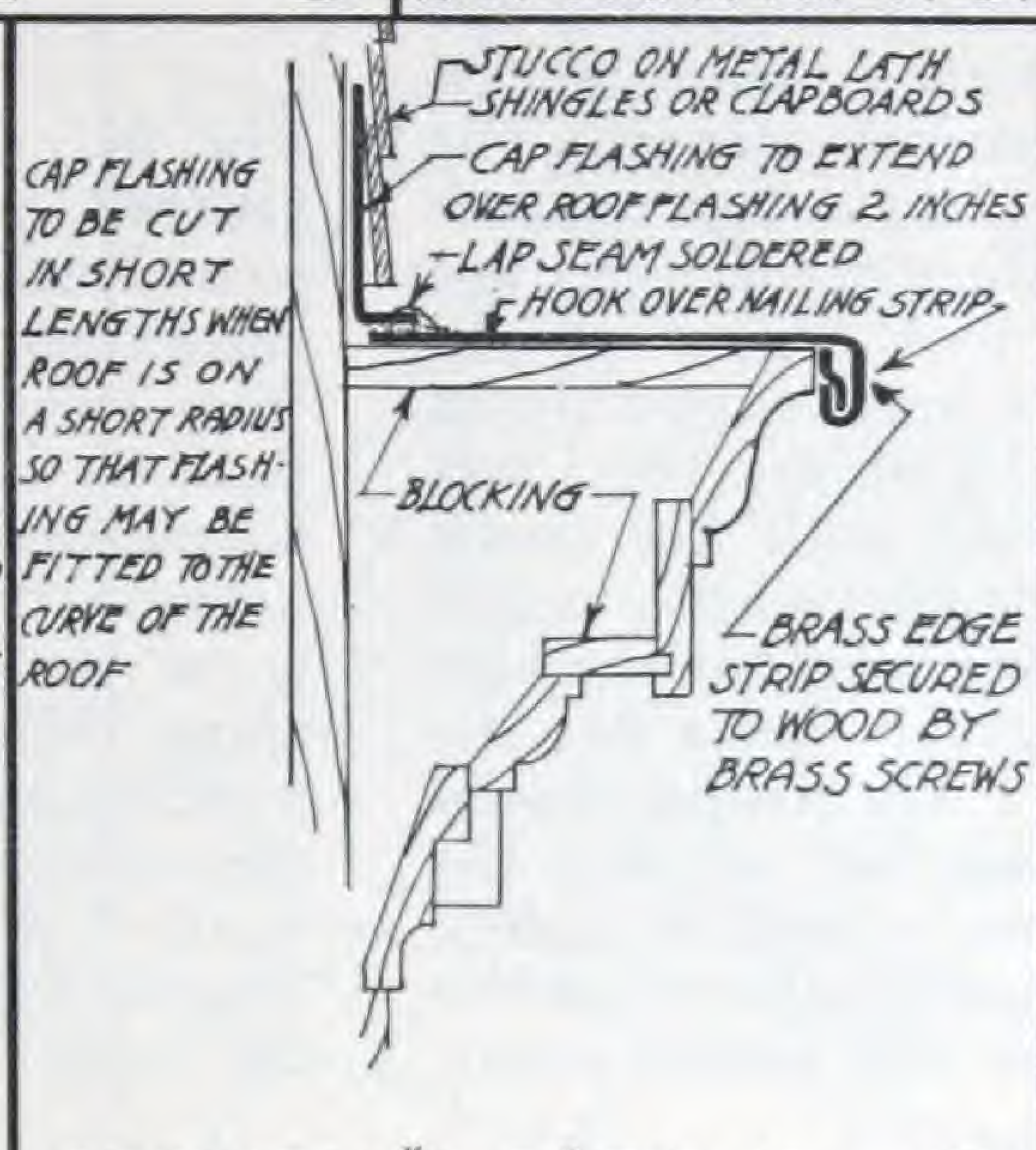
TWO WAYS OF FLASHING ROOF OF WOOD DOORWAY AGAINST A BRICK WALL (15)



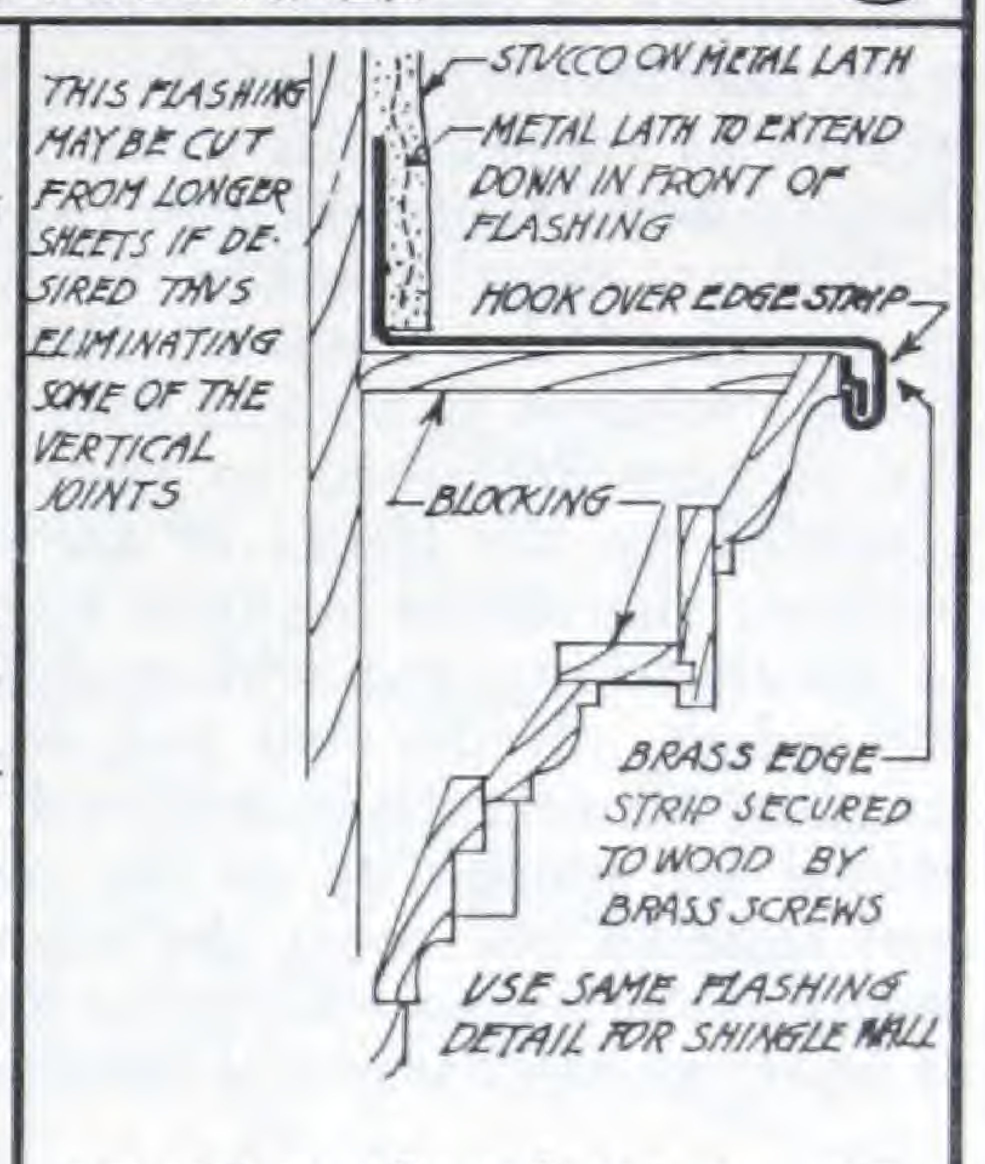
TWO WAYS OF FLASHING ROOF OF WOOD DOORWAY AGAINST A STUCCO WALL (16)



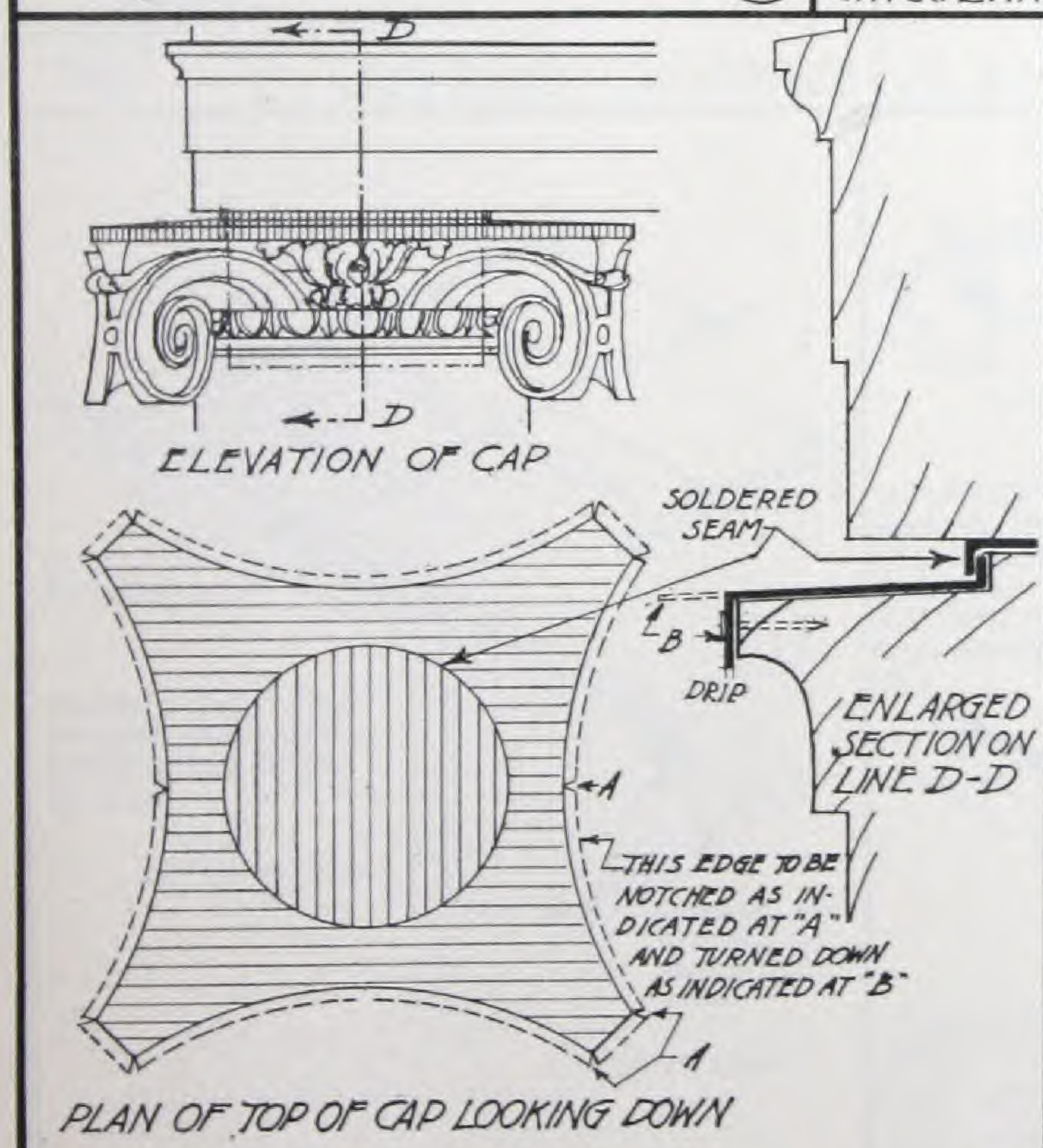
SECTION "A-A" FIG. 15 (17)



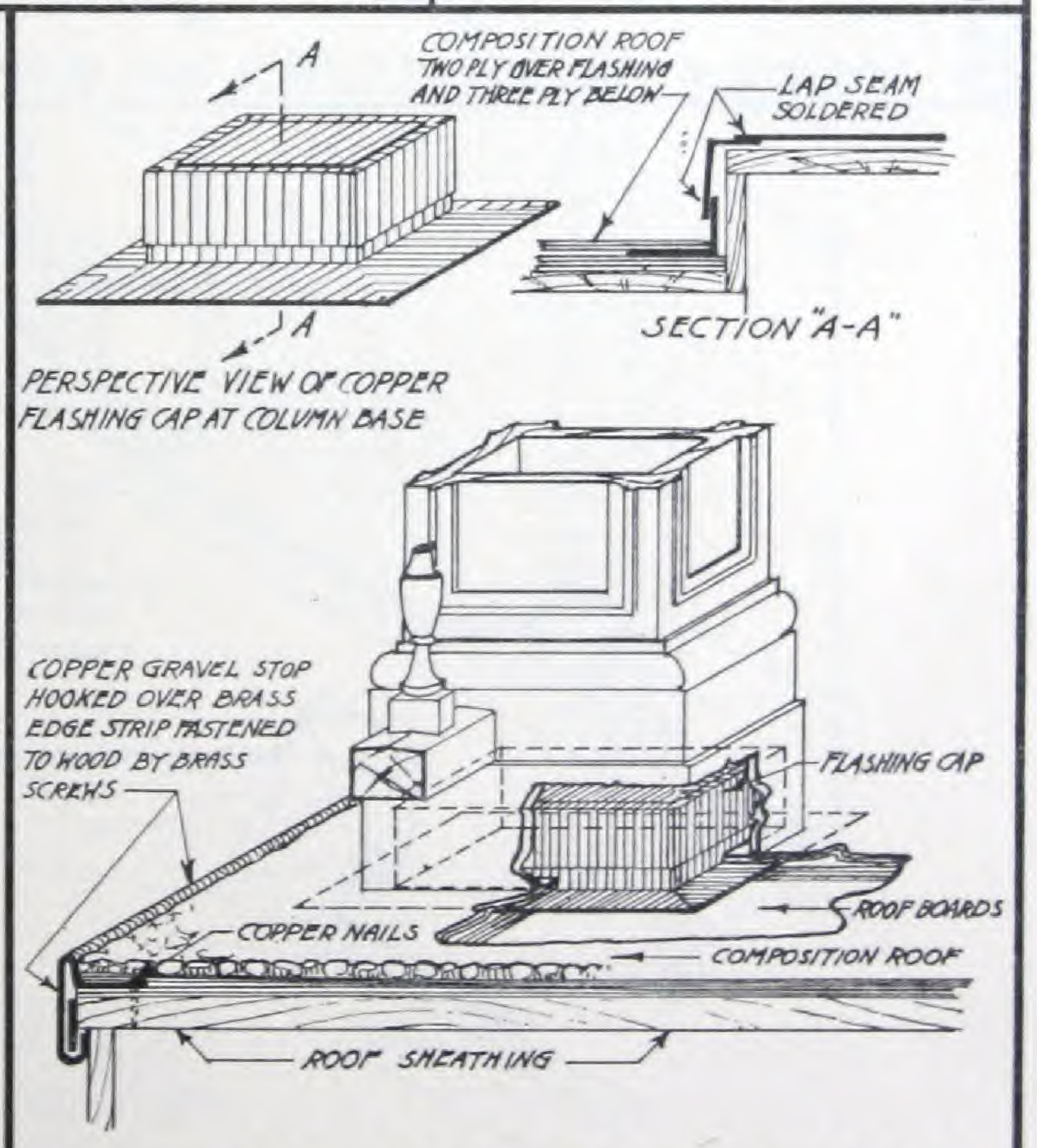
SECTION "B-B" FIG. 16 CIRCULAR HEAD (18)



SECTION "C-C" FIG. 16 (19)



FLASHING FOR A COLUMN CAP (20)

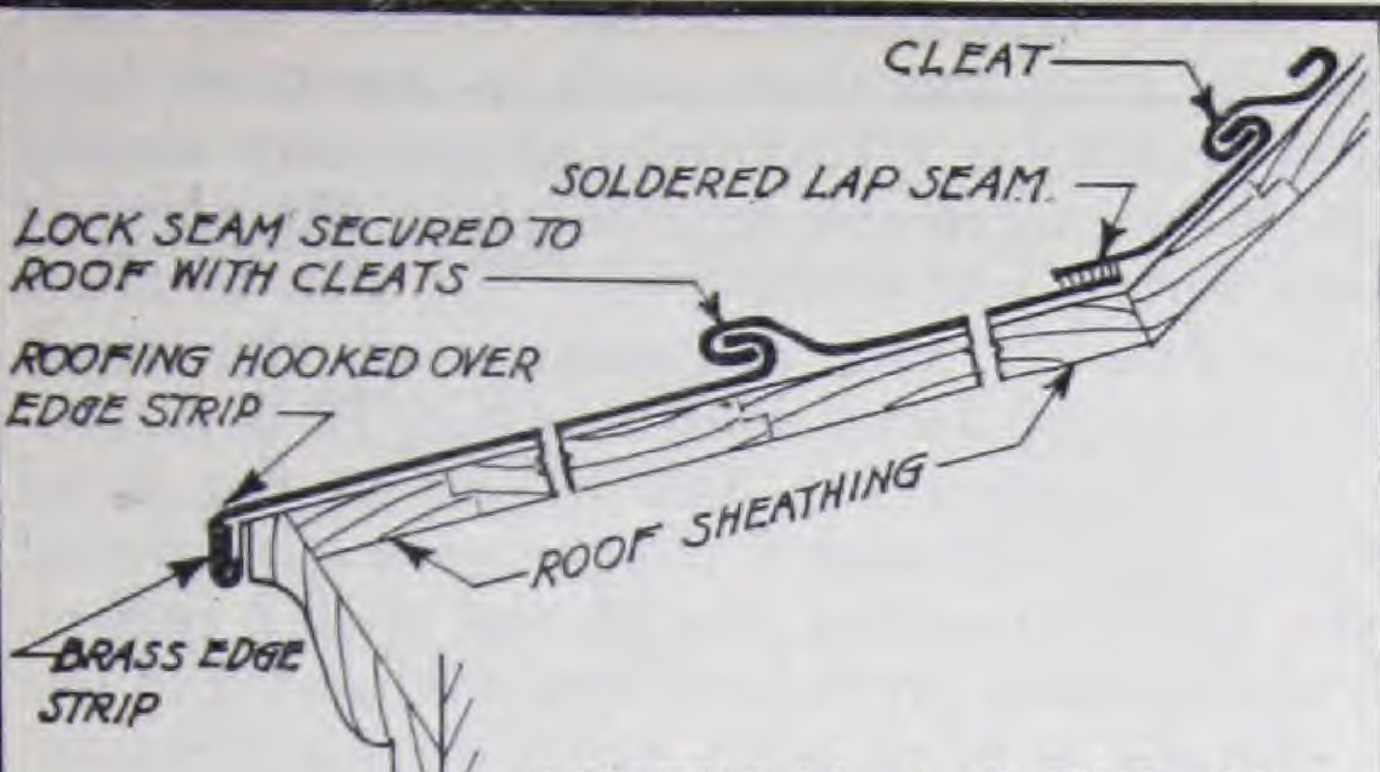


FLASHING FOR BASE OF WOOD COLUMN OF BALUSTRADE ON ROOF OF DECK (21)

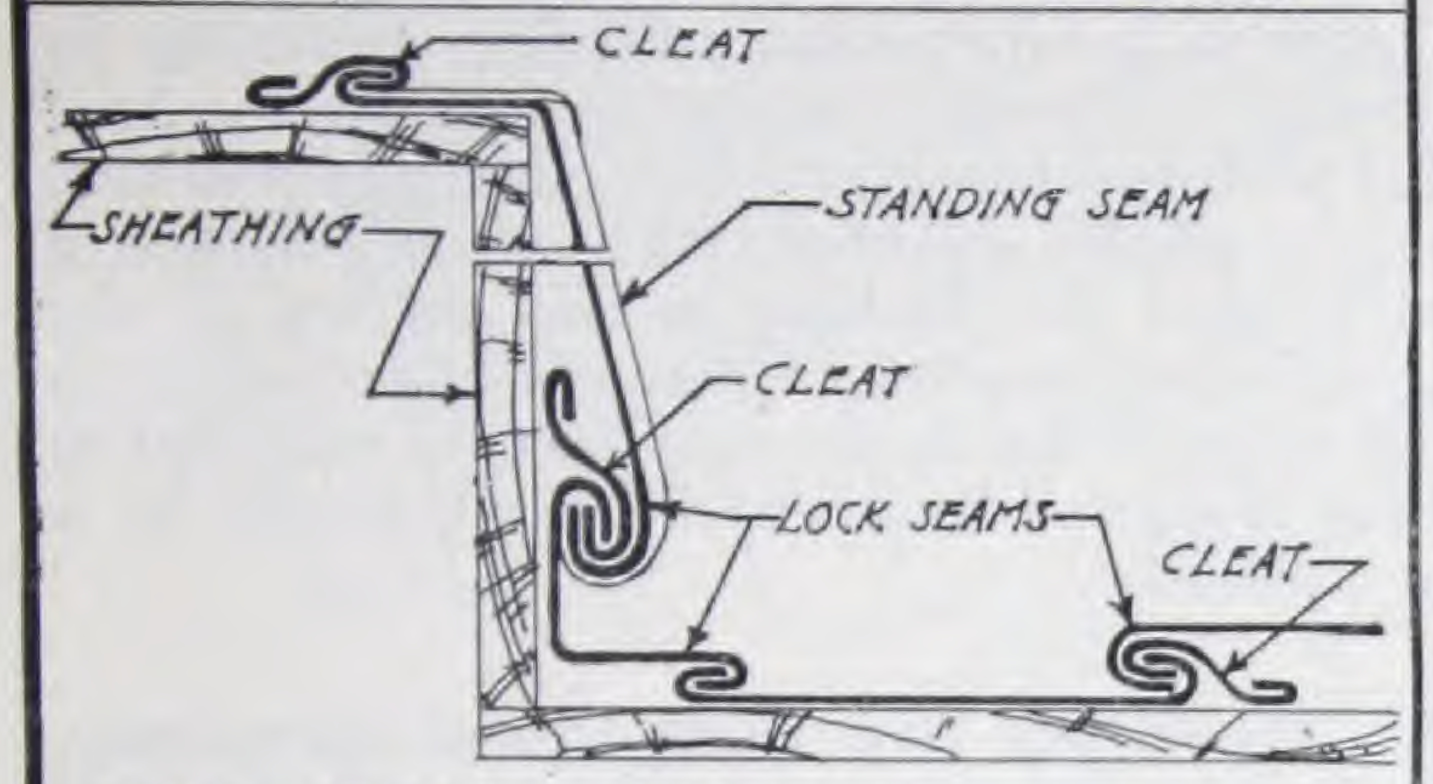
Fig. 22. Where the design calls for a recessed dormer window the method of flashing shown in Fig. 22 and detailed at the left in Sections A-A, B-B, and C-C is recommended. Attention is called to the various seams which, as well as the copper roofing, are exaggerated in order to show clearly the methods employed. The sheathing of the sides of the recess and the hips of the dormer roofing are formed with standing locked seams. All the other seams are flat locked. The method of forming the seams is explained in detail in the text on page 49. The apron extending down the slope of the roof in front of the recess deck should lap the shingles at least 4 inches and the lower edge of the copper should be turned back on itself about ½ inch for stiffness. The upper part of the deck roofing should be carried up under the wood window sill as far as possible and nailed. The copper at the sides of the recess should lap the main roof under the shingles at least 2 inches and be secured by copper cleats to the wood sheathing. The shingles may extend out over this if the design requires it, but care must be taken in nailing the shingles not to puncture the copper. The roof copper of the dormer window is hooked over a brass edge-strip in the manner described on page 54 of the text, and extended up the slopes of the roof with flat seams between the sheets secured by copper cleats nailed to the sheathing, and with standing seams at the hips and ridges. If the roof and deck are quite flat the standing seams must be soldered. The roofing should extend far enough up on the main roof so that the roof shingles will cover the copper at least 4 inches. In any event it is necessary that the copper be covered by at least two thicknesses of shingles with broken joints.

Fig. 23. One method of forming a hanging gutter and securing it to a wood roof covered with shingles is shown in Fig. 23. The upper or roof edge is turned back on itself ½ inch to engage copper cleats about 12 inches apart, which are nailed to the roof by copper nails. The outer edge or roll of the gutter contains a bronze or brass bar. To this are riveted long copper straps of $\frac{1}{16}$-inch metal about 30 inches apart extending up on the roof 3 or 4 inches above the upper edge of the copper gutter. Each strap is secured to the roof by 2 brass wood screws or nails. While it is a desirable feature for this form of gutter to be supported from below as well as from above, and a copper drip provided as shown, these features are not vital and may be omitted. Gutter-lining is sometimes used in long runs, but it is not shown in this detail as it does not affect the support of the gutter.

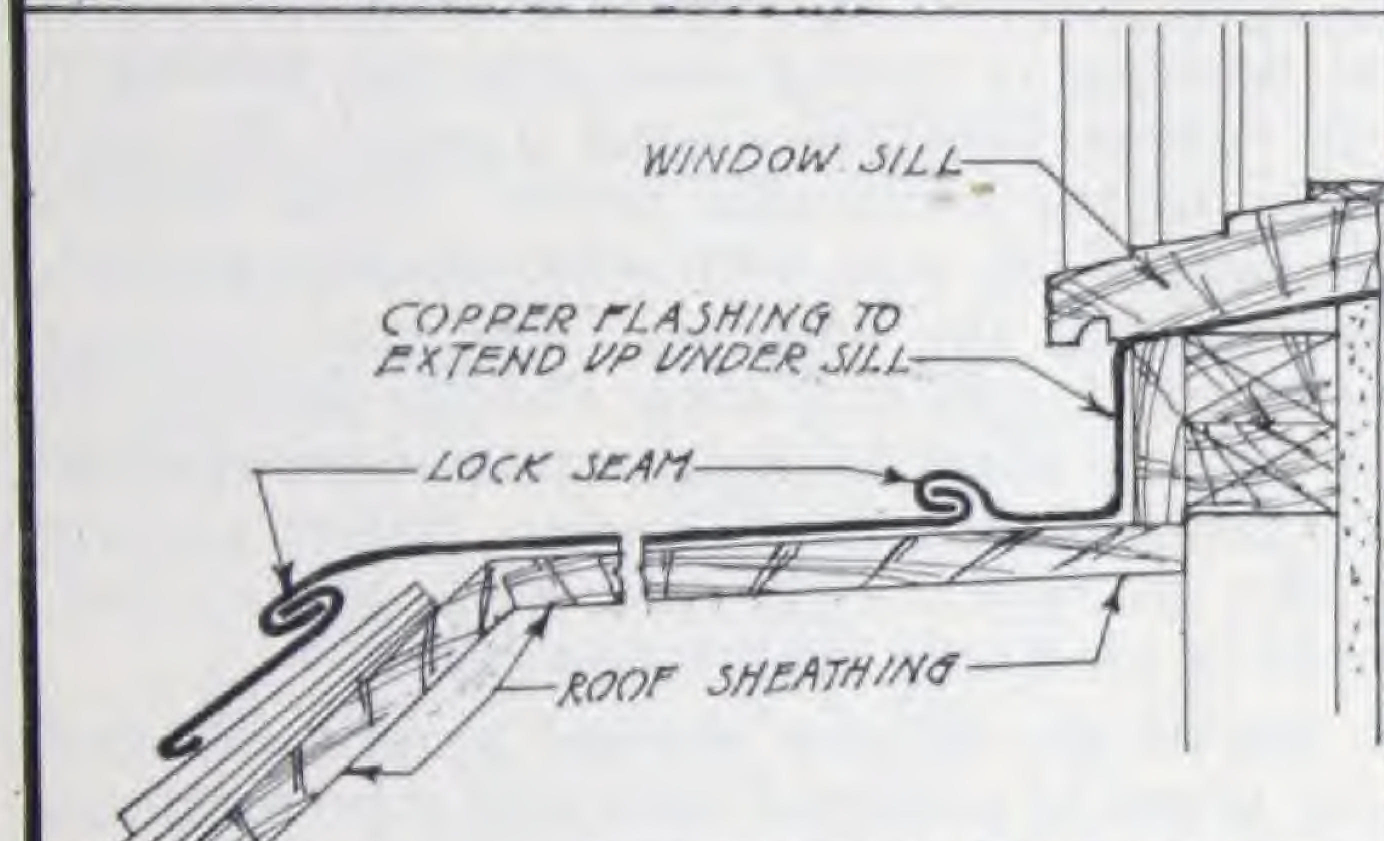
Fig. 24. Another type of gutter called a "Pole Gutter," is shown in Fig. 24. This is known in some localities as a "Gutter-Strip." In this instance the gutter is placed on the roof instead of suspended from it. The upper edge of the flashing is turned back on itself and secured to the roof sheathing by copper cleats and nails. The lower edge is also turned back on itself ½ inch for stiffness. The copper should cover the shingles at least 4 inches. The shingles along the upper edge should lap the copper at least 4 inches and the copper should be covered by at least two thicknesses of shingle. The flashing is secured at the lower end by cleats fastened to the pole. For clearness these have not been shown in the detail of the seam.



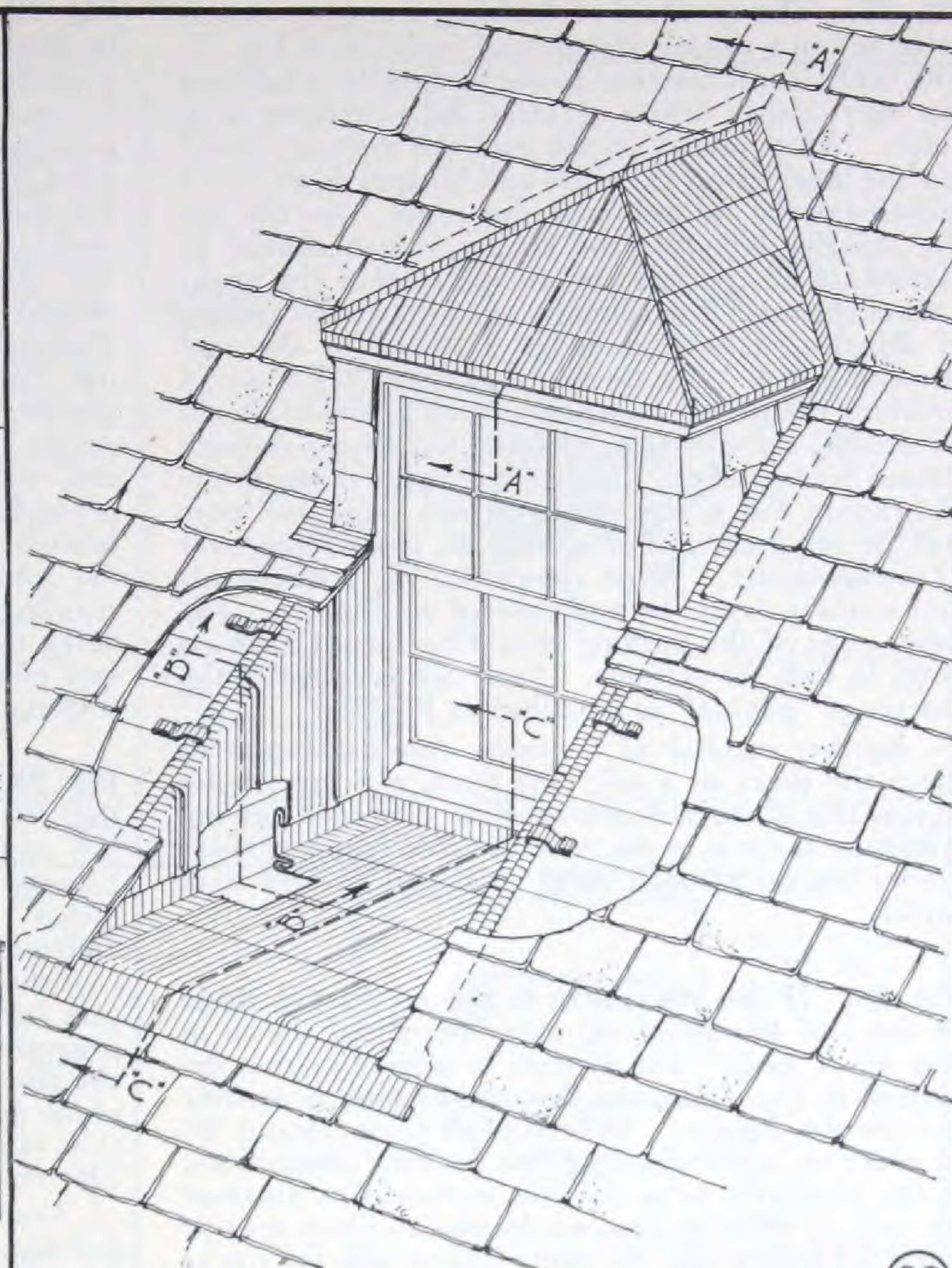
SECTION A-A FIG. 22



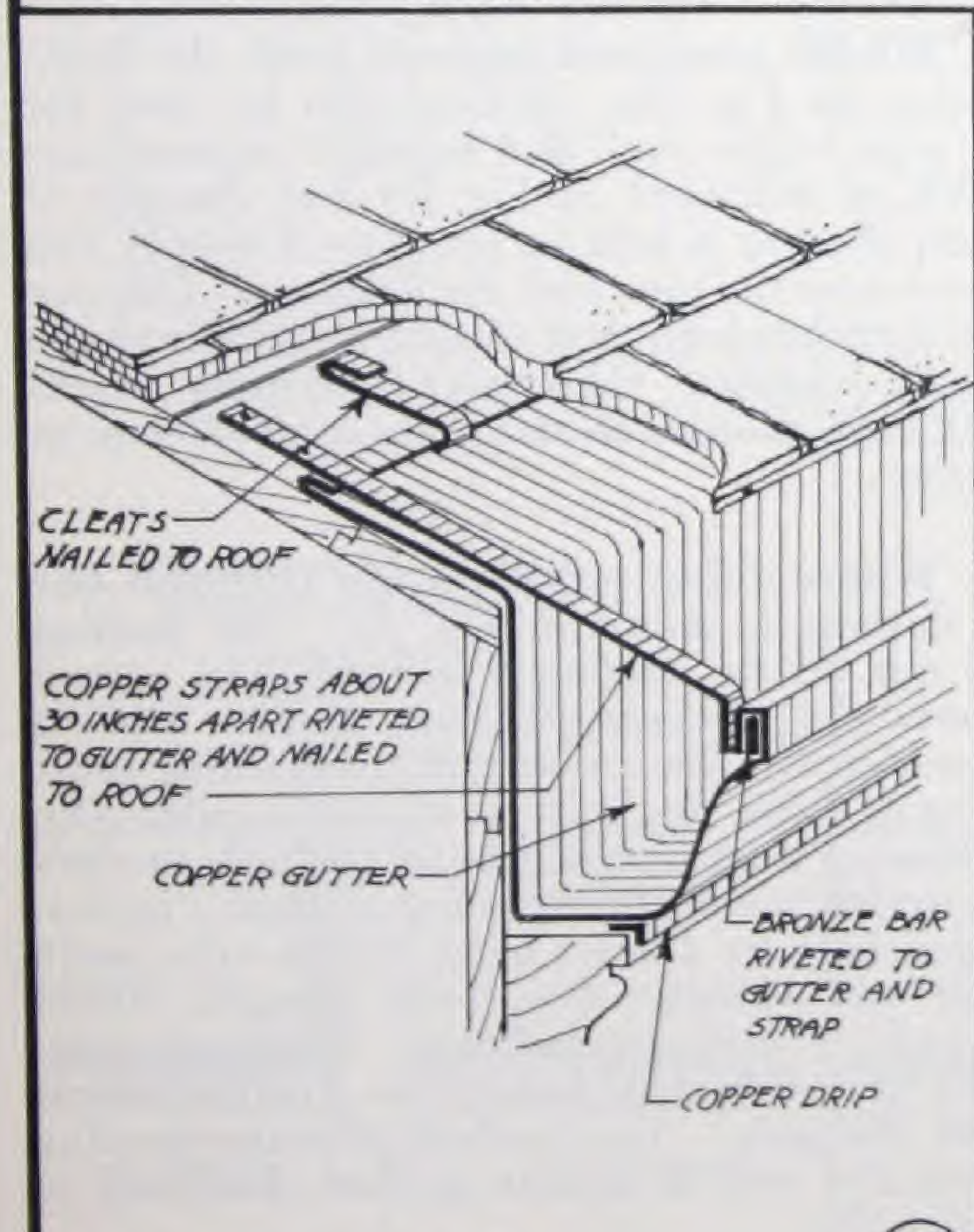
SECTION "B-B" FIG·22



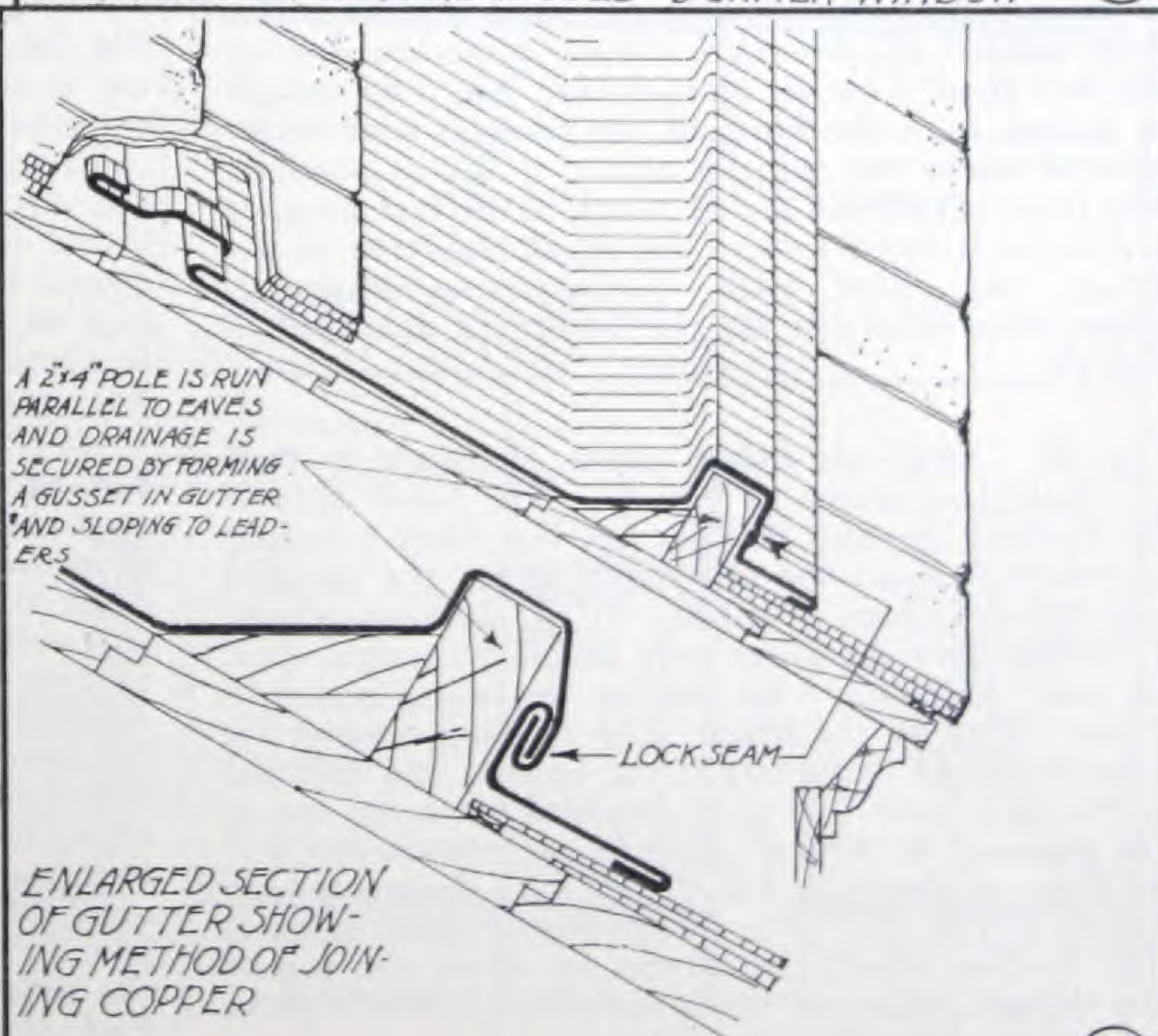
SECTION "C-C" FIG·22



FLASHING FOR A RECESSED DORMER WINDOW (22)



HUNG GUTTER (23)



POLE GUTTER (24)

Fig. 25. The method of flashing a copper ventilator set on a sloping shingle roof is shown in Fig. 25. The ventilator is fastened to the flashing by a soldered lap seam either before or after the ventilator is in place. When placed on the roof the flashing should lap the shingles on the sides and bottom from 6 to 8 inches and be formed over the edges. At the top the shingles lap over the copper, which should be carried up on the roof far enough so that the upper part of the sheet is covered by at least two thicknesses of shingles. The flashing is fastened to the roof sheathing by long brass woodscrews. To avoid breaking the shingles the holes for these screws should be drilled, not punched, and the screws set through slotted brass washers. Only 4 screws are shown in the illustration but if the ventilator is a large one more will be required. They should be spaced not over 12 inches apart. When completed the screw heads and washers should be well covered with solder. The lower edge of the flashing should be turned back on itself ½ inch for stiffness. Attention is called to the matter of "guying" as described in Fig. 26.

Another method of fastening this flashing is to place the sheet on a soft pine block and drive holes in it with a blunt nail-set—in effect a counter-sinking. After the sheet is in place on the roof ordinary wood screws are set through these holes and covered with solder.

Fig. 26. If the ventilator is placed on the ridge of the roof instead of the slope the detail shown in Fig. 26 is used. The method is similar to that described in Fig. 25 except that the flashing is entirely outside the shingles. In both cases (Figs. 25 and 26) in order to avoid strain on the flashing connections, if the ventilator be a tall one, it should be steadied by rods or wires secured to the roof. These rods or wires are fastened to the ventilator as near the top as possible by a brass collar and to the roof by brass screw-eyes or similar devices. The flashings for these consist of pieces of copper extending out on the roof about 8 inches on each side, and long enough to extend from the butts of the shingles next below up and under the shingles above as far as possible. The sheet is soldered to the shank of the fastening, or a thimble is fitted around the shank, soldered to the sheet, and filled with waterproofing-compound. These screw-eyes can also be flashed as described in Fig. 28.

Fig. 27. Vent- or other pipes through a roof are flashed as shown in Fig. 27. The lower edge of the flashing laps the shingles not less than 4 inches, but the sides and top are placed under the shingles and covered about 6 inches. If the flashing is over 12 inches wide the lower edge should be turned back on itself ½ inch. This stiffens the metal and prevents lifting by the wind. The flashing around the pipe should be flared out at the bottom and soldered to the roof sheet. It should extend up to the top of the pipe and be secured either by an iron cap screwed in place, as shown in Fig. 29, or by a copper cap, as shown in Fig. 30. (See description of these figures.) The flashing should be carried up above the top of the shingle course on which it rests and held in place by nailing along the upper edge.

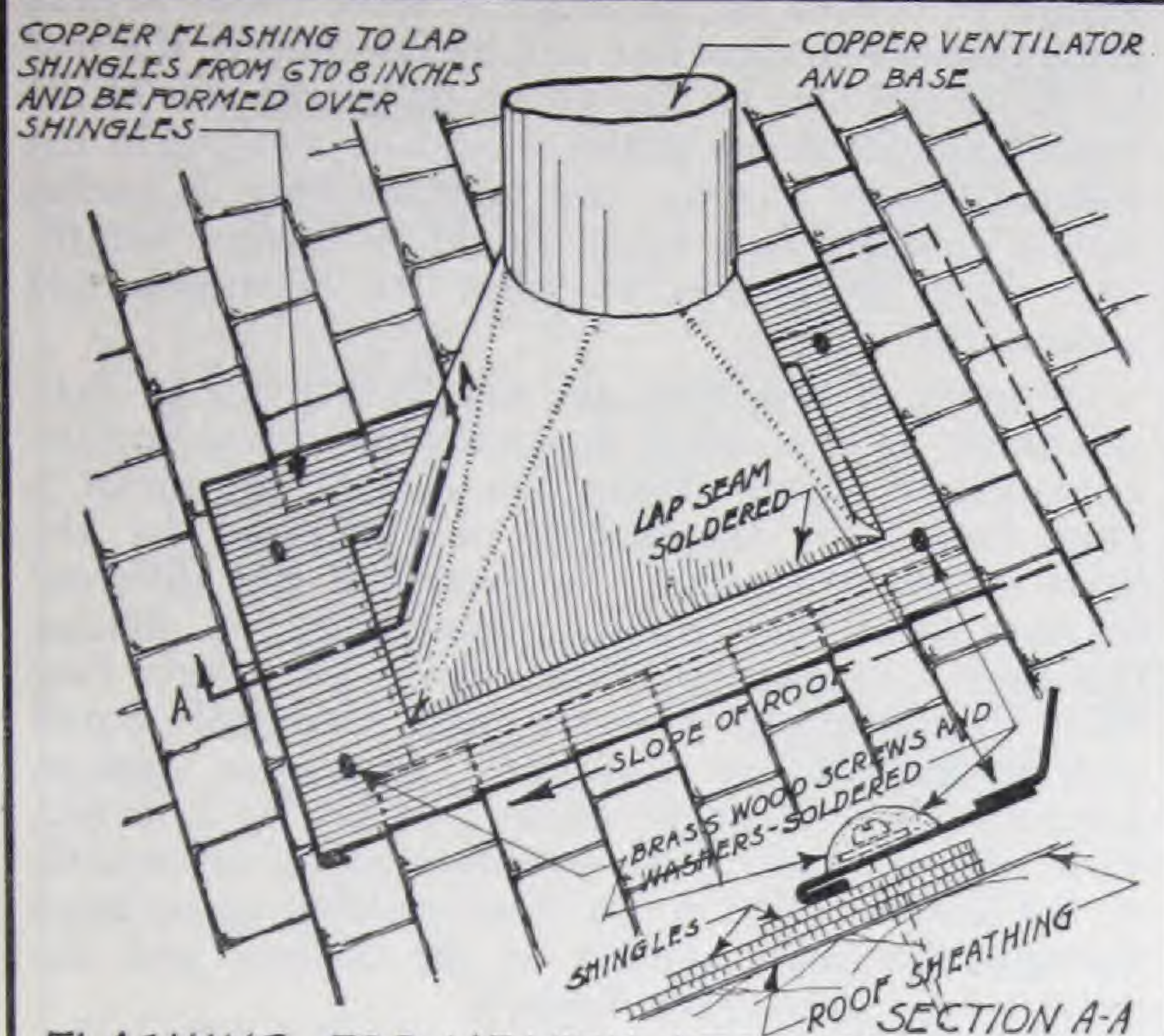
Fig. 28. Many instances occur where the roof is pierced by steel members such as struts to hold a platform or similar structure. Great care should be used at these places not only to make the point of penetration water- and damp-proof but also to allow room for expansion and contraction of the steel. For this purpose the detail shown in Fig. 28 is recommended. The composition roof is laid in the usual way close to the steel and a copper collar is formed around the steel extending out on the roof 2 inches. The ends of the collar are lapped and soldered and the pan thus formed is filled with pitch or other waterproofing-compound. The steel should be heated with a torch to secure proper adhesion, expecially in cold weather. The part extending out on the roof is covered with two layers of fabric, the copper having been first carefully swabbed with pitch. Where a tile roof is used the flashing is laid on top of the regular roof waterproofing. When it is necessary to make the vertical and horizontal parts of this pan in two pieces the joint between the parts should be a soldered lap seam.

Fig. 29. There are two methods of terminating the flashing when a vent-pipe comes through the roof. One method is shown in Fig. 29. The horizontal flashing is turned out over the roofing 6 inches. A copper sheet is placed around the pipe and soldered to the horizontal sheet. Some roofers coat the outside of the pipe with white lead or asphaltum before placing the flashing. The roof flashing is covered by two layers of roofing and the flashing on the pipe is held in place by a cap screwed on the top of the pipe and enclosing the flashing. Before placing this cap the threads are coated with white lead. This method is used only with screw-pipe.

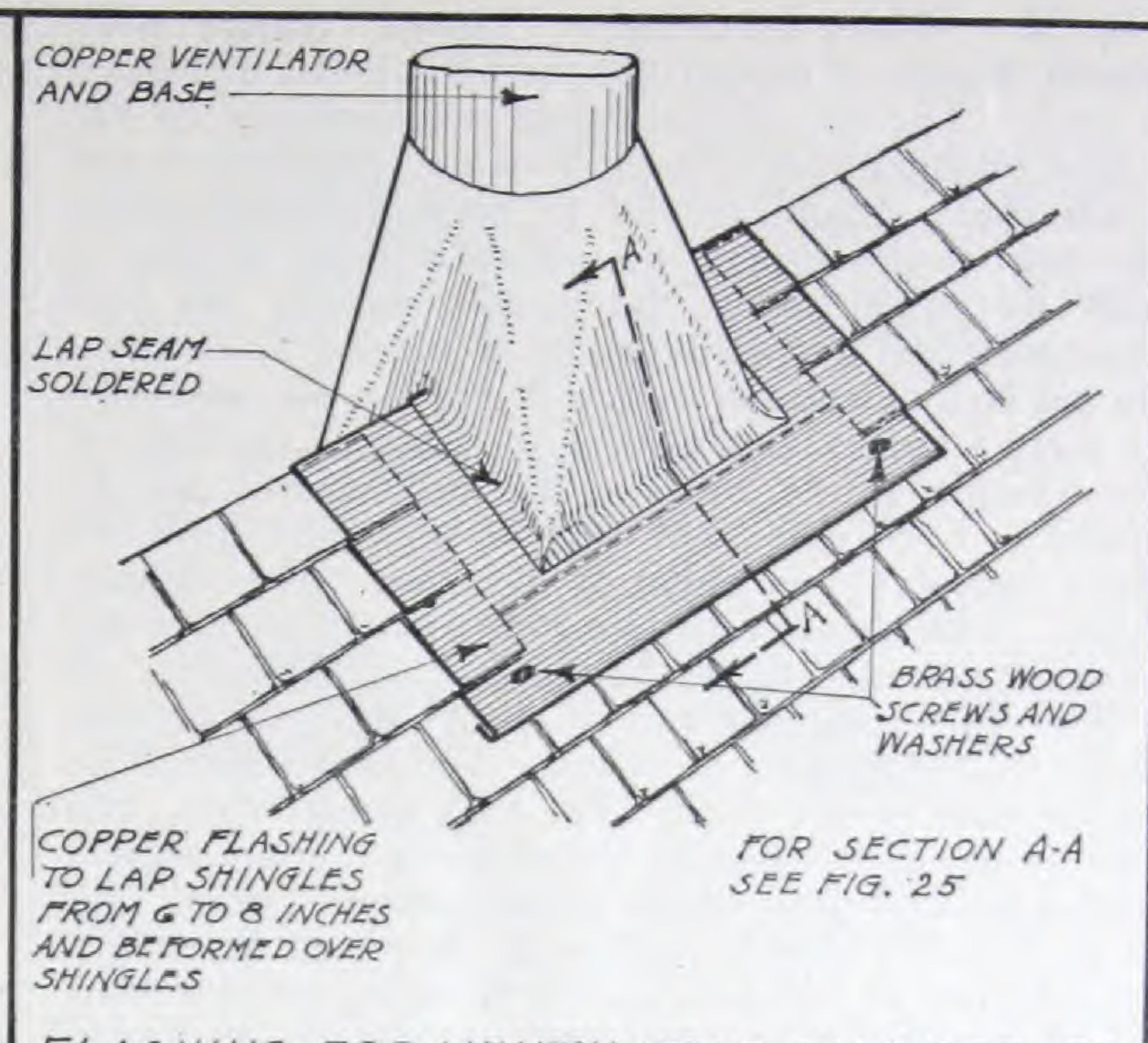
There are on the market several practicable and satisfactory types of patented vent and pipe flashings for various kinds and conditions of roofing.

Fig. 30. Where cast-iron pipe is used the flashing is shown in Fig. 30. It may also be used for threaded pipe. The roof and vertical portions are constructed as described in Fig. 29 but the top of the vertical portion is held in place by a copper cap forced down over the pipe and the flashing. This cap should be 6 inches high and should project into the pipe at least 2 inches. The vertical flashing should be carried high enough so that the cap will lap at least 4 inches.

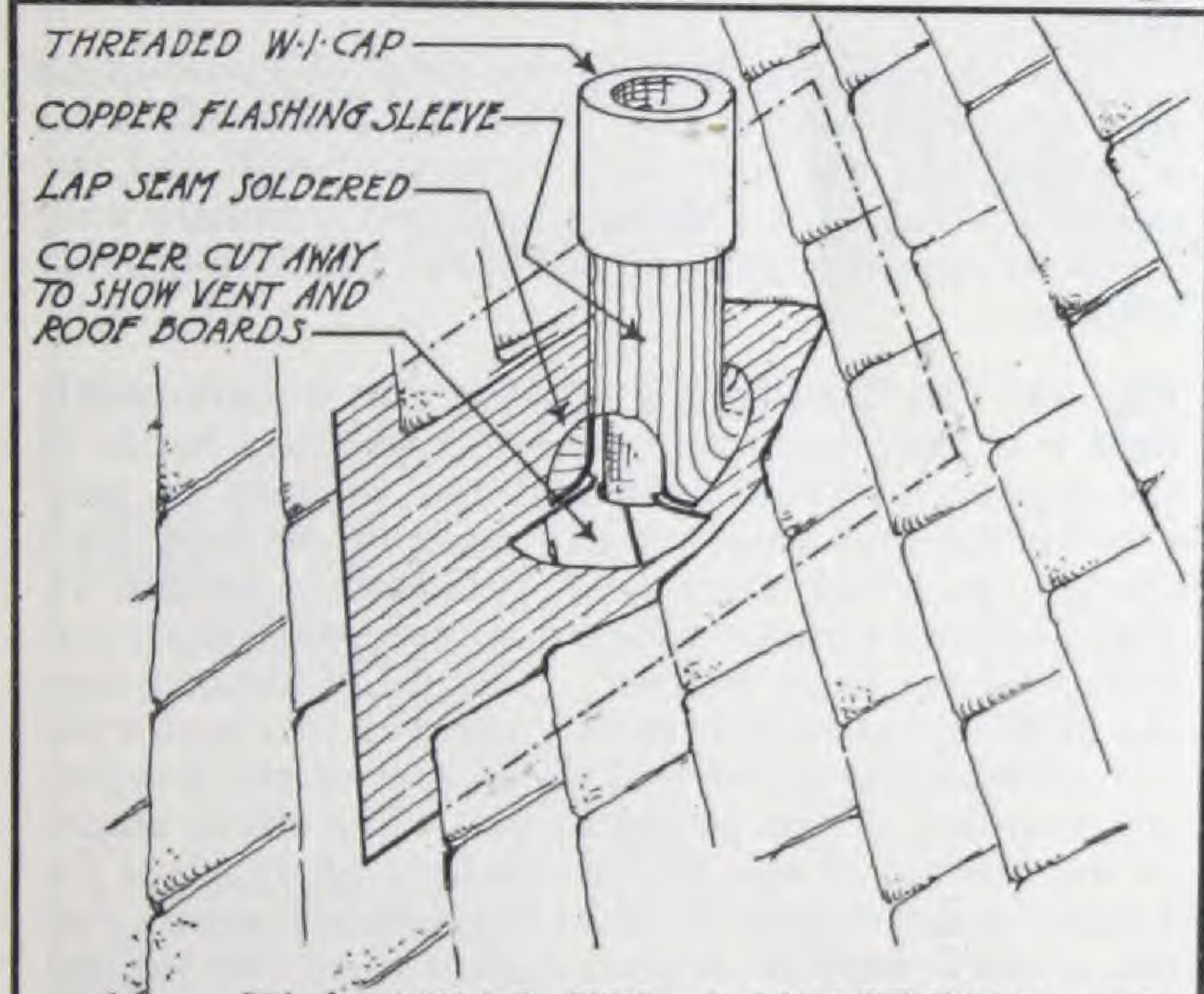
Fig. 31. Where a flag pole extends through the roof the flashing is shown in Fig. 31. The flashing is turned out on the roofing 6 inches. The copper collar around the pole is lapped over the base flashing and well-soldered. The collar and the flashing must be kept away from the pole to allow for vibration. A flared hood is then placed around the pole extending down so that it will lap the collar at least 3 inches. This hood is held by a brass band 1 inch wide set in white lead and bolted. The lower edge is turned back on itself ½ inch for stiffness. Very tall poles are usually braced by rods secured to a collar several feet up on the pole. The method of waterproofing the rods at the roof is similar to that described in Figs. 26 and 28.



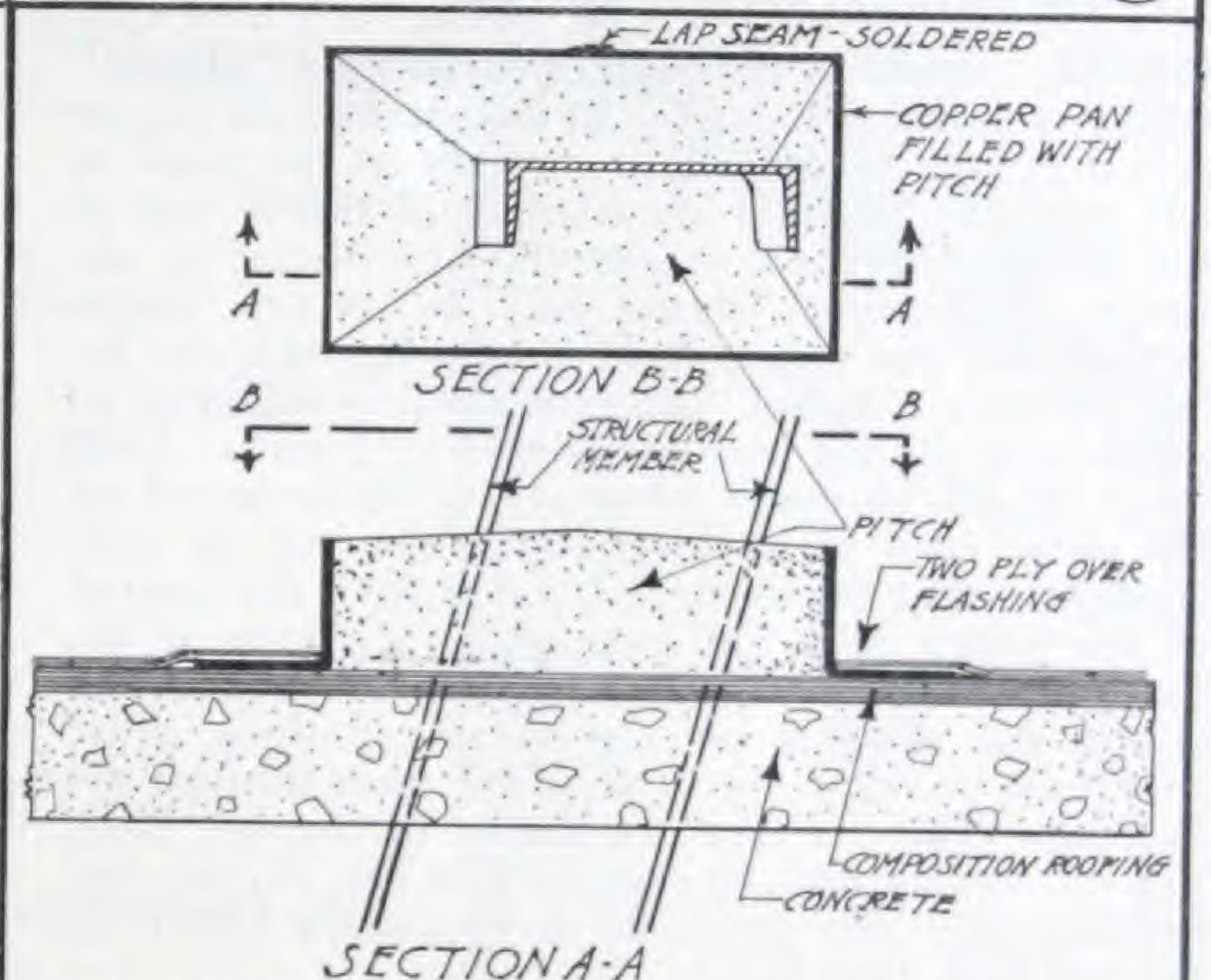
FLASHING FOR VENTILATOR ON SLOPE OF SHINGLE ROOF (25)



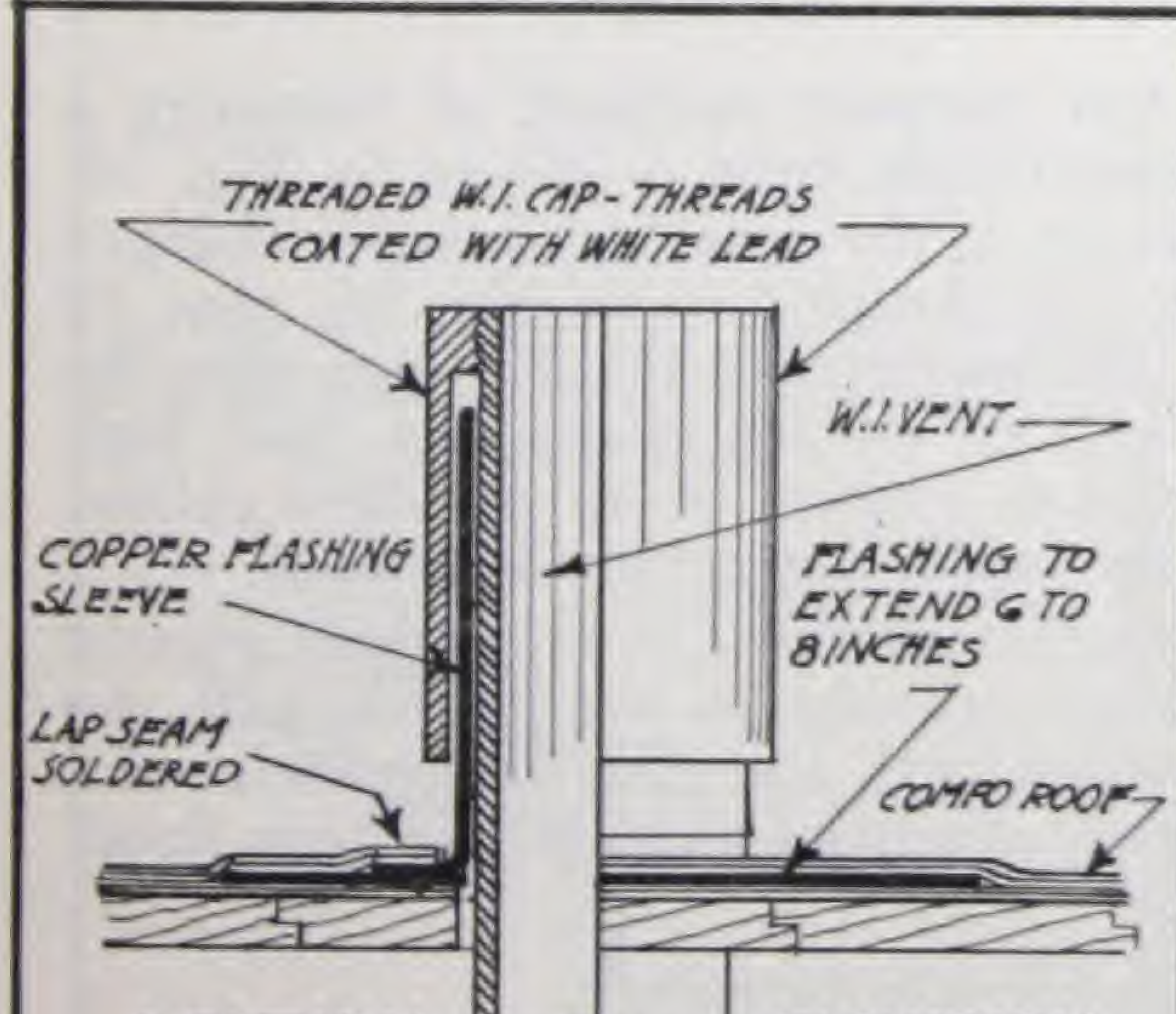
FLASHING FOR VENTILATOR ON RIDGE OF SHINGLE ROOF (26)



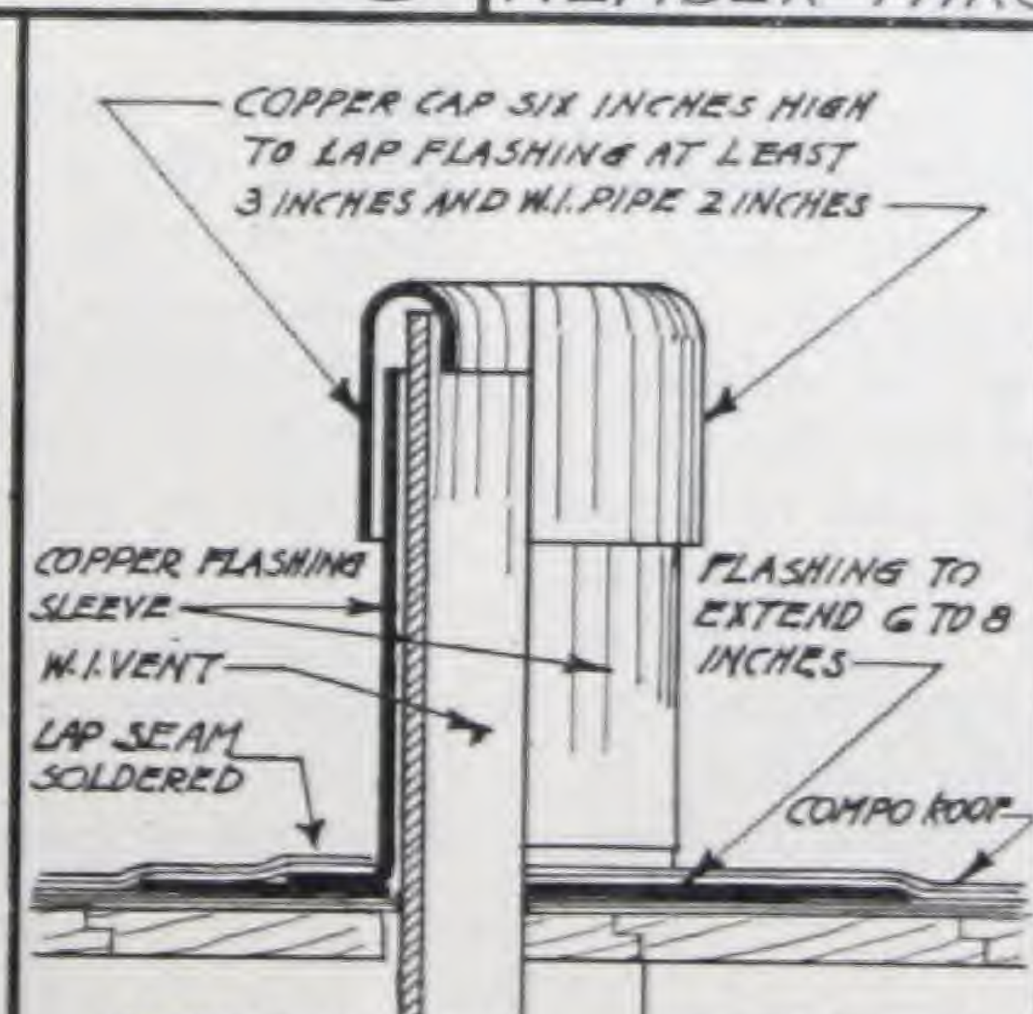
FLASHING FOR A VENT PIPE THRU A SLOPING SHINGLE ROOF (27)



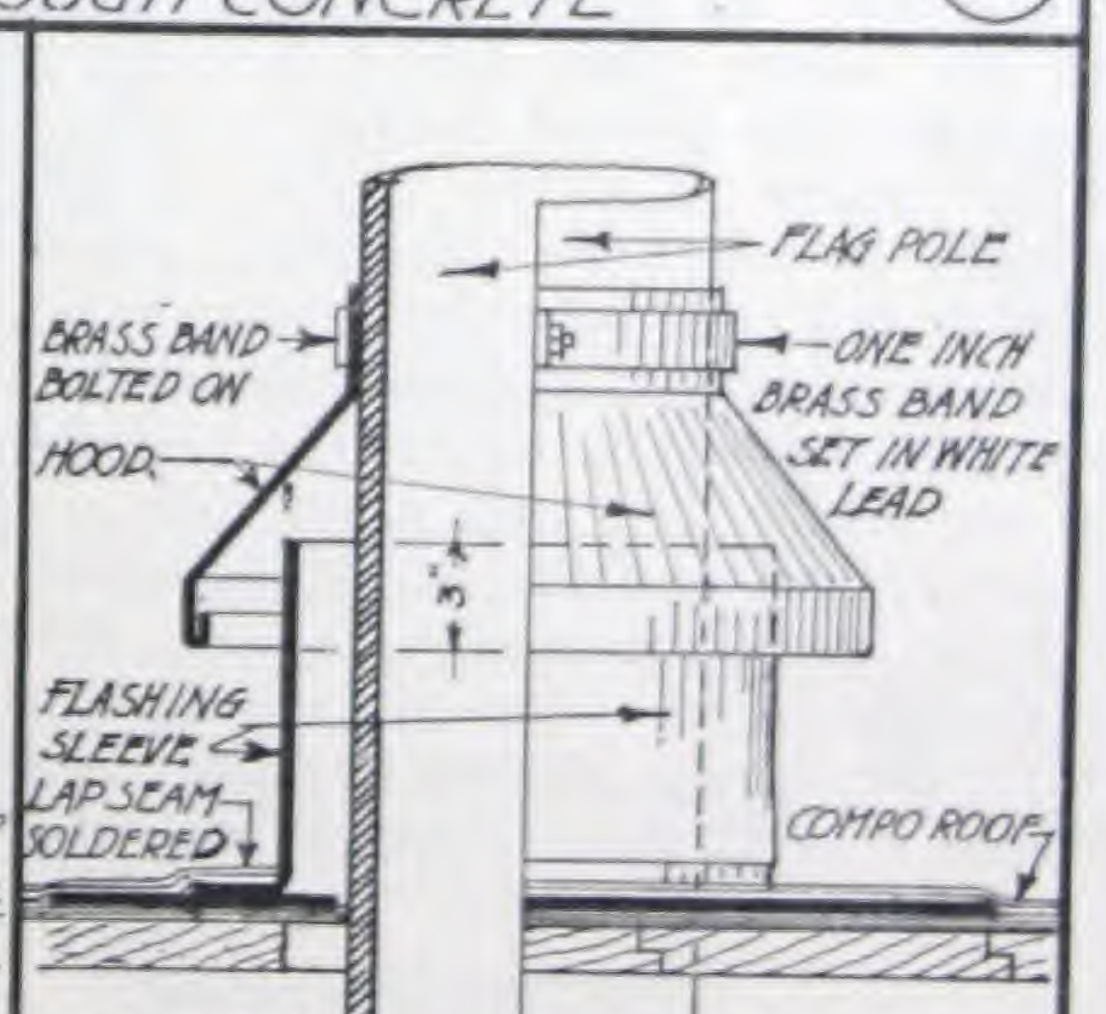
FLASHING FOR STEEL STRUCTURAL MEMBER THROUGH CONCRETE (28)



FLASHING FOR IRON VENT WITH SCREW CAP (29)



FLASHING FOR IRON VENT WITH COPPER CAP (30)



FLASHING FOR FLAG POLE (31)

Fig. 32. When forming a "closed" valley with small sheets of copper the method shown in Fig. 32 is used. The size of sheet used is determined by the length of shingle and the pitch of the adjoining slopes. Each sheet should extend at least 2 inches above the top of the shingle on which it rests so that it may be nailed along the upper edge to the roof sheathing and not through the shingles. Each sheet should be long enough so that it will lap the one below at least 3 inches, but always set back of the butt of the shingle above so that the copper will not be visible. Each sheet will then be separated from the sheet below by a course of shingles. (See Section A-A.) The sheets must be wide enough so that the vertical distance from the bottom of the valley to a line connecting the top of the sheets (see Section B-B) will be at least 4 inches. The sheets should be nailed only at the upper edge with copper nails, and laid at the same time as the shingles. Some roofers prefer to bend these sheets with a center "crimp" (see D-D, Fig. 33) thereby stiffening the sheet, forming a straight line to which to set the shingles, and preventing the possibility of water from one slope being forced above the flashing on the opposite slope when the drainage from one slope is greater.

Fig. 33. Another method of forming a "closed" valley is shown in Fig. 33. In this method the copper is laid in long narrow sheets directly on the paper or felt covering the roof sheathing and before any of the shingles are laid, except the first course at the eaves. The copper sheets may be of any length desired but the upper sheet should lap the one below at least 4 inches, unless the lap is soldered, in which case the lap may be reduced to 1 inch. Each sheet should be nailed about every 18 inches along the outer edge of its long dimension, and be wide enough so that the vertical distance from the bottom of the valley to a line connecting the tops of the sheets (see Section D-D) is at least 4 inches. In laying the shingles on top of this flashing great care must be taken not to drive any nails through the flashing. The "crimp," as shown in Section D-D, Fig. 33, has its uses as explained in Fig. 32, but the flashing may also be made in the shape shown in Section B-B, Fig. 32.

Fig. 34. A factory saw-tooth roof presents many problems. In order to obtain maximum light and at the same time avoid direct sunlight, the roof windows are placed facing in a northerly direction. This means that the gutter is always in shadow, which, in northerly localities, permits the snow to gather and remain in the gutter for long periods. The "line of minimum shadow" shown in Fig. 34, indicates the point down to which the sun shines on the slope of the roof. The area to the left of this line receives more or less sunlight according to the hour, and the area to the right receives none. This line as well as the angle of the face containing the windows varies with the design of the building and the latitude in which it is built. In every case the copper flashing should be carried up the slope at least 1 foot beyond the minimum-shadow line and be fastened to the roof by cleats and also be carried up under the sills of the windows. All sharp angles should be avoided in the construction of gutters, and in those over 24 inches wide a soldered lock seam should be formed lengthwise down the center to allow for expansion and contraction.

Gutters of this type are usually subject to hard treatment as it is often necessary to shovel out the accumulated snow. When this is done the metal is often broken by the shovels or punctured by the heels of the workmen. To overcome this different schemes have been tried. Steam coils for melting the snow are probably the best. In every case there should be provision for quick drainage. Small electric heaters are sometimes placed at outlets. Sometimes a steel angle, about 5 inches by 5 inches, with edge notches, is placed inverted in the middle of the gutter. The water from melting snow flows through the small notches to the outlets, and the snow is kept thoroughly drained.

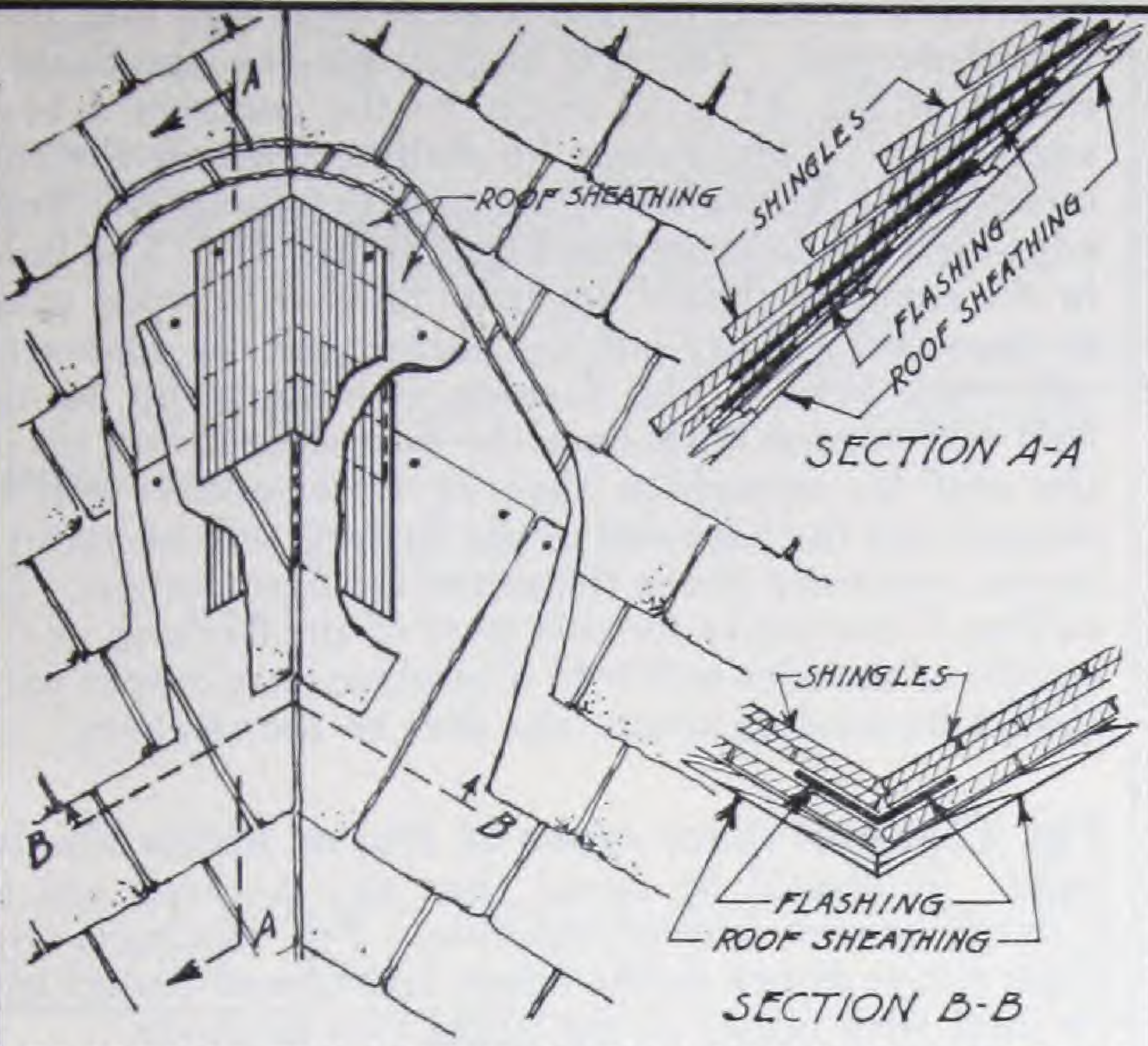
If the gutters are to be cleared of snow by workmen with shovels, snow boards are absolutely necessary.

Two methods of flashing the ridge of a saw-tooth roof are shown in Fig. 34. The one at the left is for a shingle roof above a copper-sheathed wall and the one at the right for a shingle roof over a shingle wall. In each case the edge is turned back ½ inch to provide stiffness.

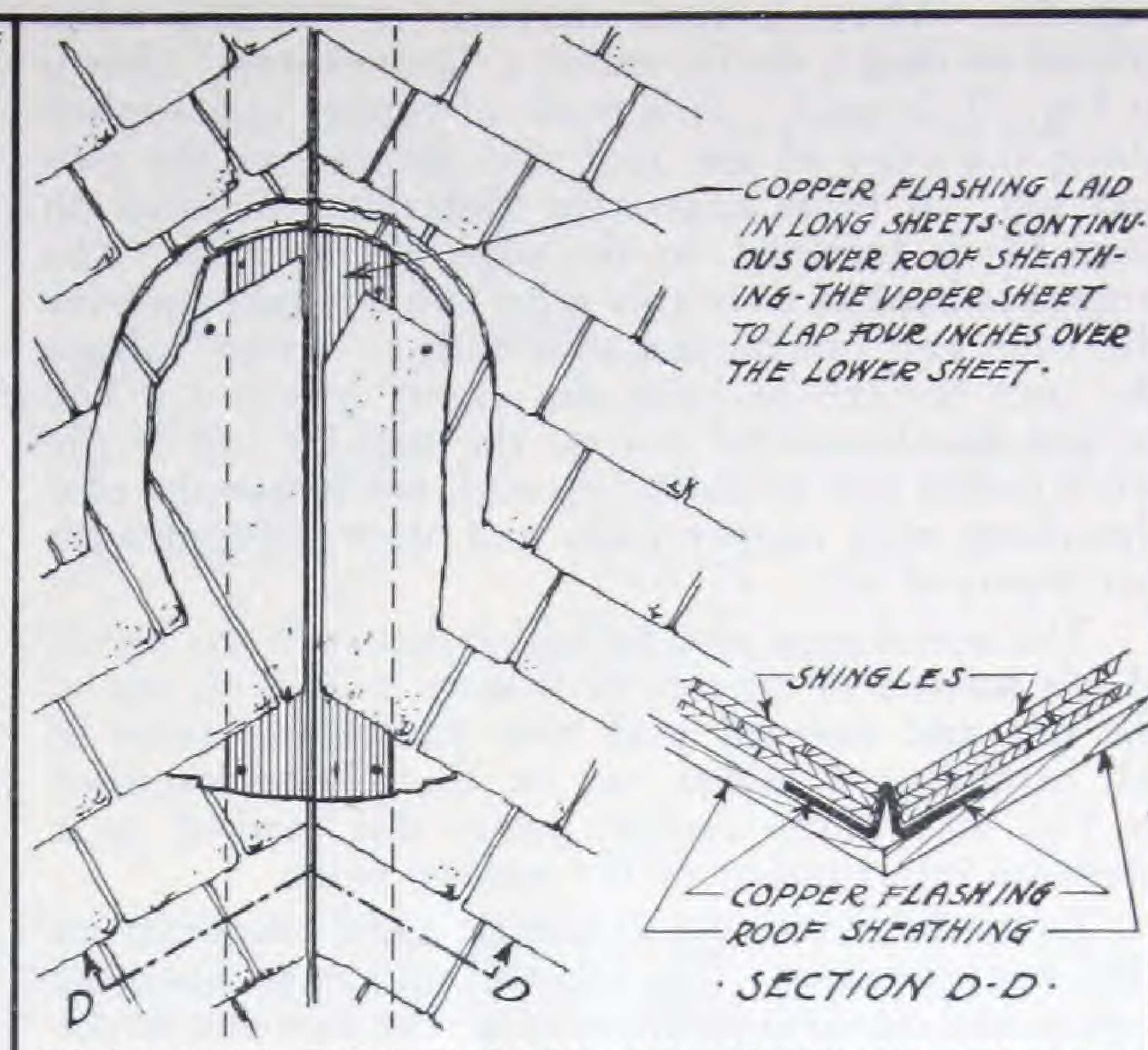
Fig. 35. In building a gutter for a saw-tooth roof it is very important to avoid all sharp bends of the copper, to avoid sudden drops, provide an easy flow for the roof water, and to carry the flashing high enough to avoid chance of overflowing behind it. Fig. 35 shows a gutter where many of these important features have been omitted. The short distance that the flashing has been carried up on the roof and walls is a constant source of leakage in case of the temporary stoppage of the gutter outlet. The sharp angles at the bottom of the gutter will be a likely place for a crack in the copper to occur through expansion, and the vertical drop of several inches from the sloping roof to the bottom of the gutter will cause wear by erosion. All these points may be avoided by proper design.

Fig. 36. Another correct method of forming a gutter for a saw-tooth roof is shown in Fig. 36. Note that the course of the drainage water is changed gradually instead of abruptly as in Fig. 35, that all sharp angles in the copper are avoided and that the flashing is carried up on the walls and roof high enough to avoid any chance of an overflow caused by stoppage of the leader outlets of the gutter.

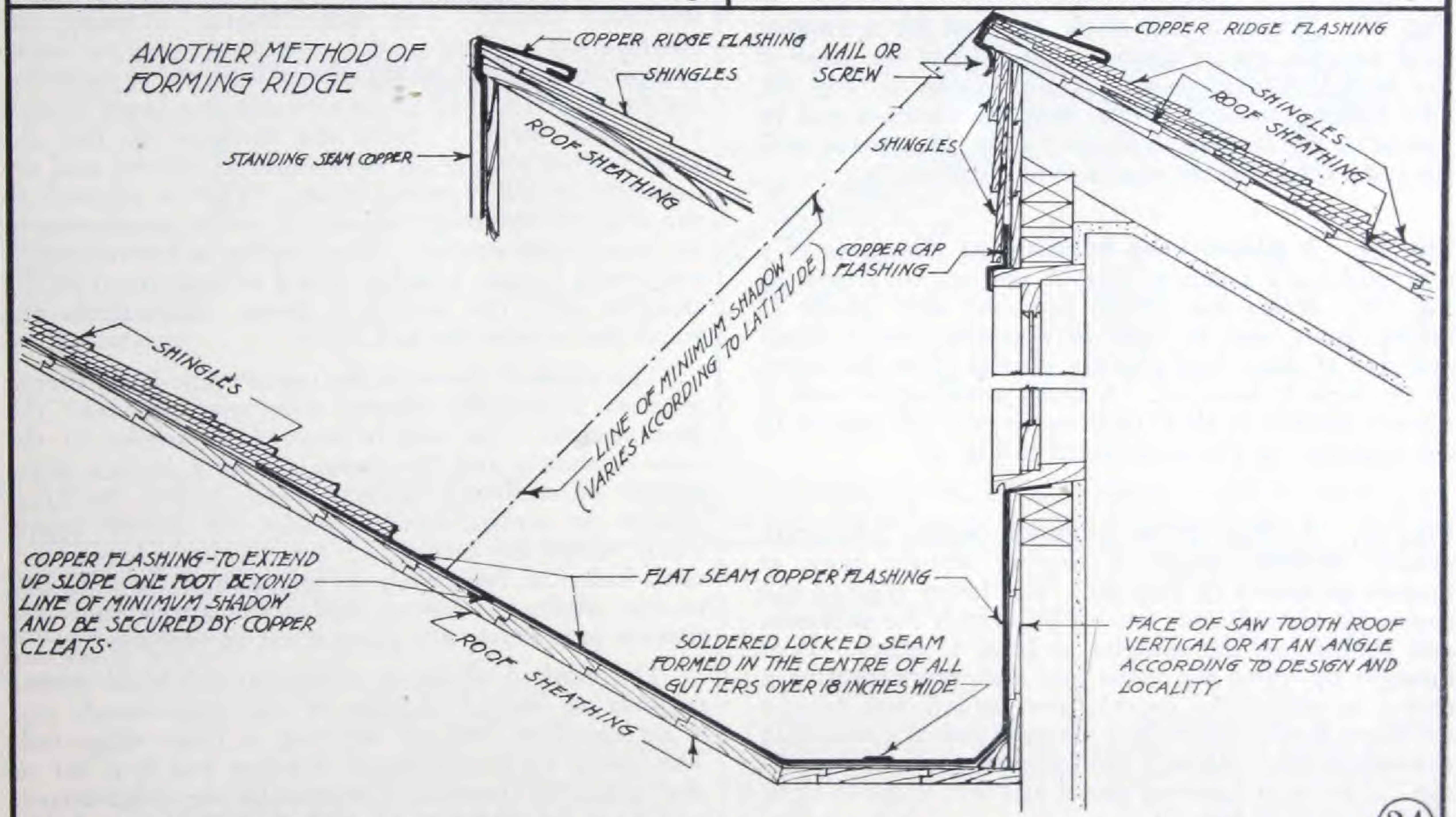
Scuppers should be provided at the ends of gutters of this type. They provide an overflow in case the leaders become obstructed, and give timely notice of a stoppage before any material damage has been done.



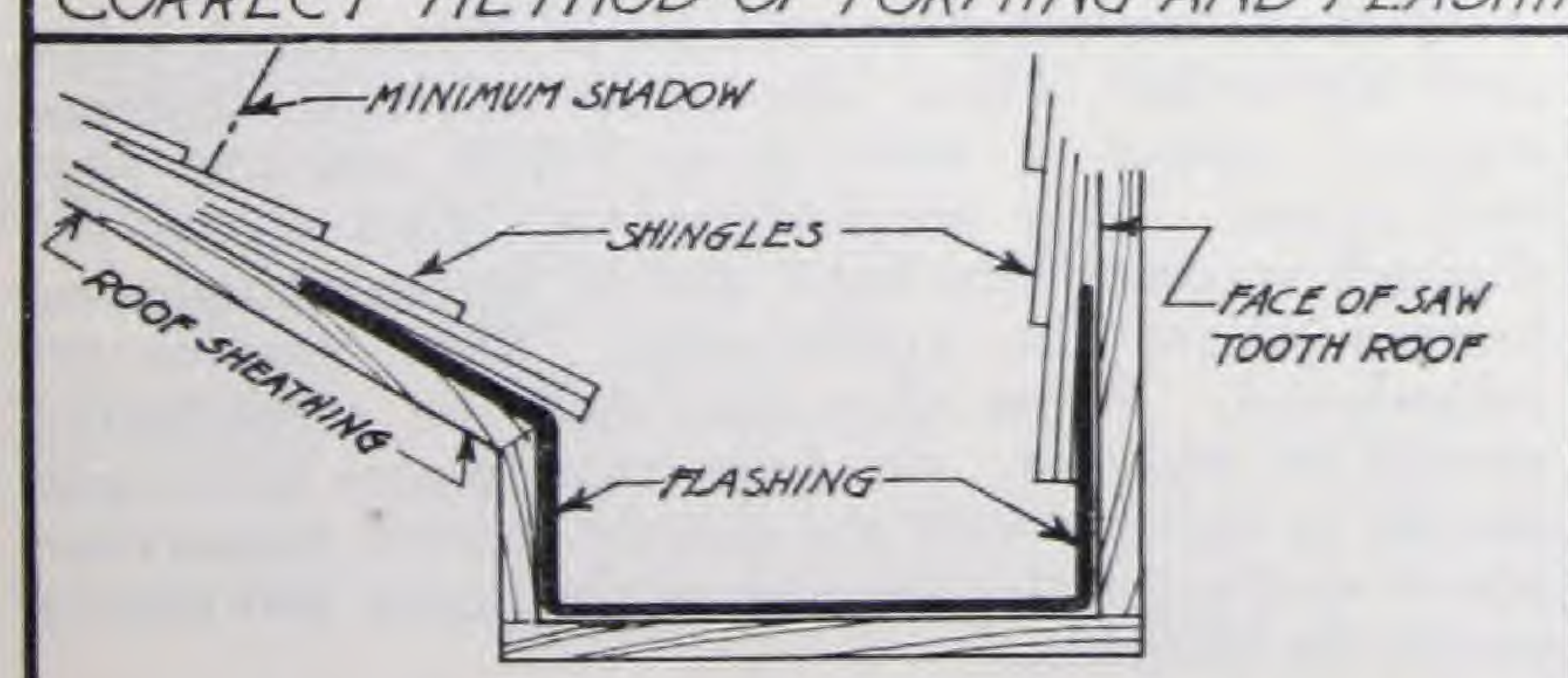
FLASHING FOR A CLOSED VALLEY USING SHORT SHEETS INTERWOVEN WITH SHINGLES (32)



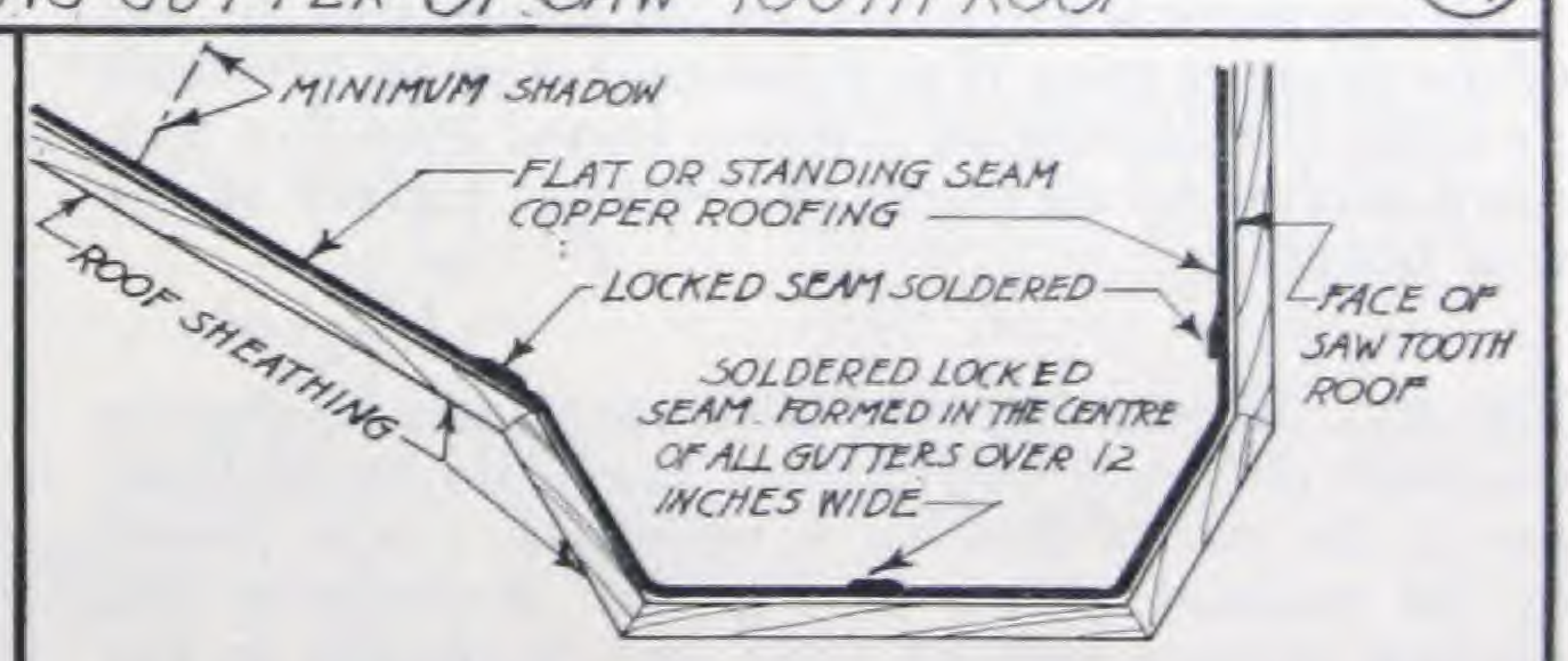
FLASHING FOR A CLOSED VALLEY USING LONG SHEETS UNDERNEATH SHINGLES (33)



CORRECT METHOD OF FORMING AND FLASHING GUTTER OF SAW TOOTH ROOF (34)



AN INCORRECT METHOD OF FORMING GUTTER FOR SAW TOOTH ROOF (35)



ANOTHER CORRECT METHOD OF FORMING GUTTER FOR SAW TOOTH ROOF (36)

Fig. 37. When a roof surface is covered with gravel or slag a device called a "gravel-stop," shown in Fig. 37, is used. It is made of copper and applied along the edge of the roof and secured at the side and top. A brass edge-strip (described in detail on page 54) is fastened to the edge of the roof. The copper is hooked over this strip and brought up over the edge and out on the roof with a "crimp" above the roof surface to keep the gravel in place. The copper should extend out on the roof on top of the felt 4 inches and be nailed through the felt to the roof sheathing with copper nails and then covered with two layers of felt.

The metal may also be laid in between the layers of felt instead of on top, or it may be laid on top of the felt and covered with two additional layers of felt extending 6 inches out on the roof as described in Fig. 40. Many roofers prefer this method as it prevents interruption of the roofing work.

THE COPPER SHOULD NEVER BE LAID DIRECTLY ON THE ROOF BOARDS. The felt will pull away from the copper and an open joint result at the junction of the copper and the felt.

Fig. 38. When a flat deck covered by a copper roof is built over a sloping shingle roof the edge ot the deck is flashed in the manner shown in Fig. 38. The flashing should lap the shingles 4 inches and be joined to the copper roofing by a flat lock seam with the seam turned in the direction of the flow.

Fig. 39. A gravel-stop flashing at the edge of a roof laid on a concerte slab is secured as shown in Fig. 39. Holes are drilled into the slab about 12 inches apart and ⅜ inch in diameter and a small cylinder of sheet lead slightly shorter than the depth of the hole is inserted. A brass wood-screw with a slotted washer is then used to fasten the copper to the concrete, as shown in detail in Fig. 63.

Fig. 40. A flat deck covered with felt-and-gravel roofing above a sloping shingle roof, is flashed as shown in Fig. 40. The lower edge of the copper is turned back on itself ½ inch for stiffness, and should lap the shingles at least 4 inches. It is brought up on to the main roof and, after forming a crimp to retain the gravel, is extended out on the roofing 4 inches and nailed about 8 inches apart near the inside edge, through the felt into the roof sheathing. The joint between metal and felt is made tight as described in Fig. 37.

If the vertical distance from the shingles to the top of the crimp is more than 8 inches it may be advisable to make the flashing in 2 pieces joined by a flat lock seam secured by cleats to the vertical surface of the roof boards.

Fig. 41. When clay roof tiles are used on a sloping concrete slab roof and project but little beyond the eaves, the use of flashing is necessary. It is placed in the manner shown in Fig. 41. Sometimes this flashing takes a molded form and is treated in the design as a cornice, but the method of application is still essentially that shown in Fig. 41, except that the copper may be formed in two parts with a horizontal lock seam joining the parts at or near the first horizontal sleeper. The first step in placing the flashing shown in Fig. 41 is to secure to the concrete a brass edge-strip. This is done by drilling holes in the concrete about 12 inches apart and fastening the brass edge-strip as described in Figs. 39 and 63. The holes in the concrete should never be filled with wood plugs as the wood will dry out and shrink and the edge-strip will work loose. The flashing is brought up on the wall and turned back over the first sleeper and up on the roof far enough so that no water-pocket will be formed and the high end of the flashing will be about 2 inches vertically above the top of the first sleeper. No nailing is necessary for this part of the flashing as the weight of the tiles will hold it in place, but copper nails should be used to secure the tiles to the sleepers.

Fig. 42 shows three types of Hip or Ridge Flashings. It should be noted that the methods are to a large extent interchangeable. For instance, the brass straps shown in the upper right-hand corner can be used with either of the other two methods.

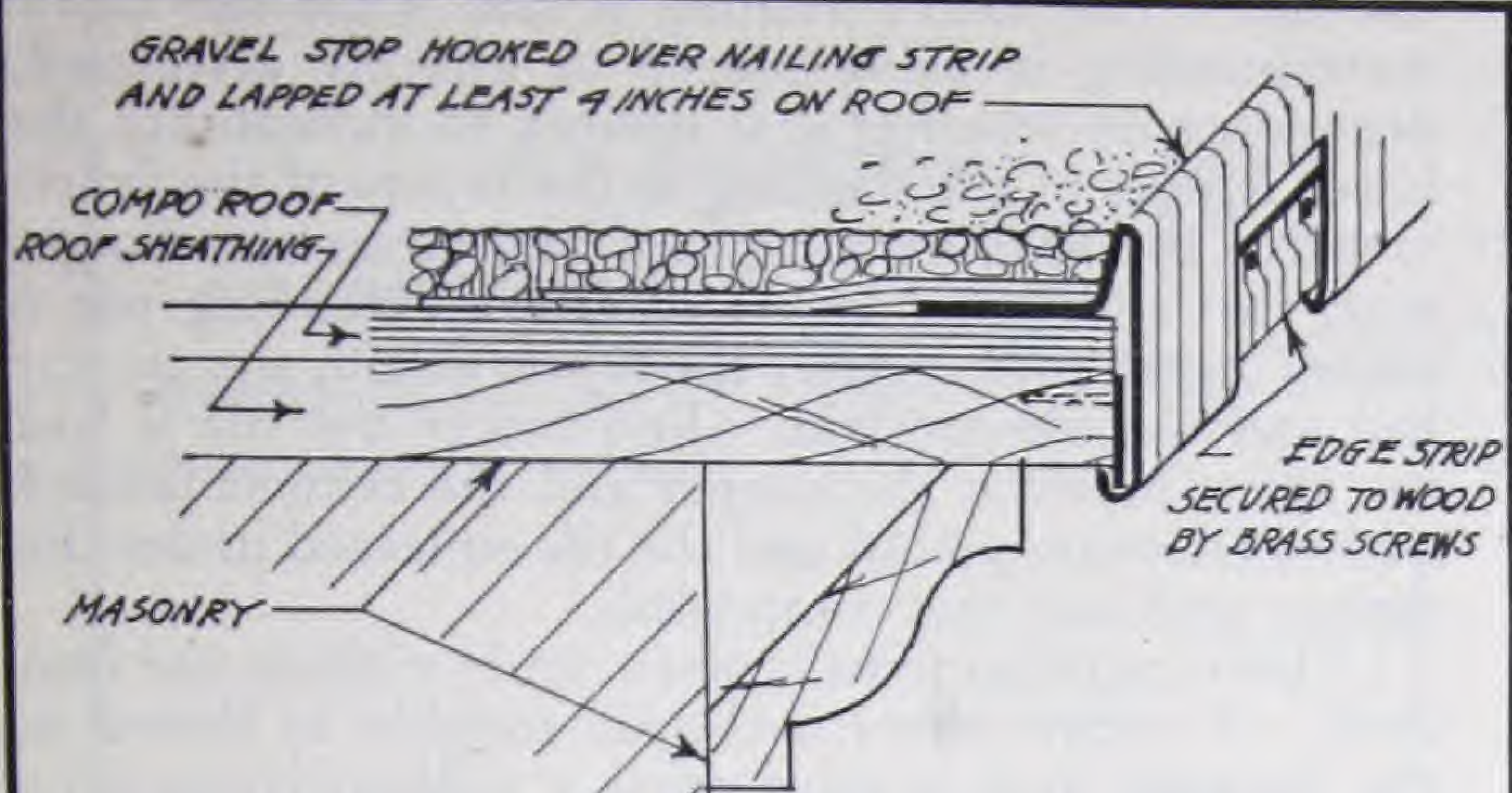
When a low ridge-flashing without any projecting roll is desired it can be made as shown in the upper left-hand corner. The ridge boards covering the shingles are secured to the roof by nailing to blocks placed at intervals on the sheathing (the shingles being cut to fit around), or on a continuous block formed of ⅞-inch strips. After the shingles are laid the ridge boards are placed over them as shown, and are covered by the flashing piece. This is secured to the edge of the ridge boards by nails, as shown, or by brass wood screws. The flashing is given a slight projection (about 1 inch), which is bent down to the shingles after the nailing is done. This sheds the water and covers the nail holes.

The method shown in the upper right-hand corner requires a specially shaped ridge-piece to take the flashing roll. The roll is secured by screws in the sides as shown, and the apron, if over 4 inches wide, should be stiffened against wind action by brass clamps or straps, spaced about 30 inches apart. These straps are secured by screws through countersunk holes as indicated, or are sometimes soldered to the apron. If placed under the apron they are riveted to it before the piece is set in position.

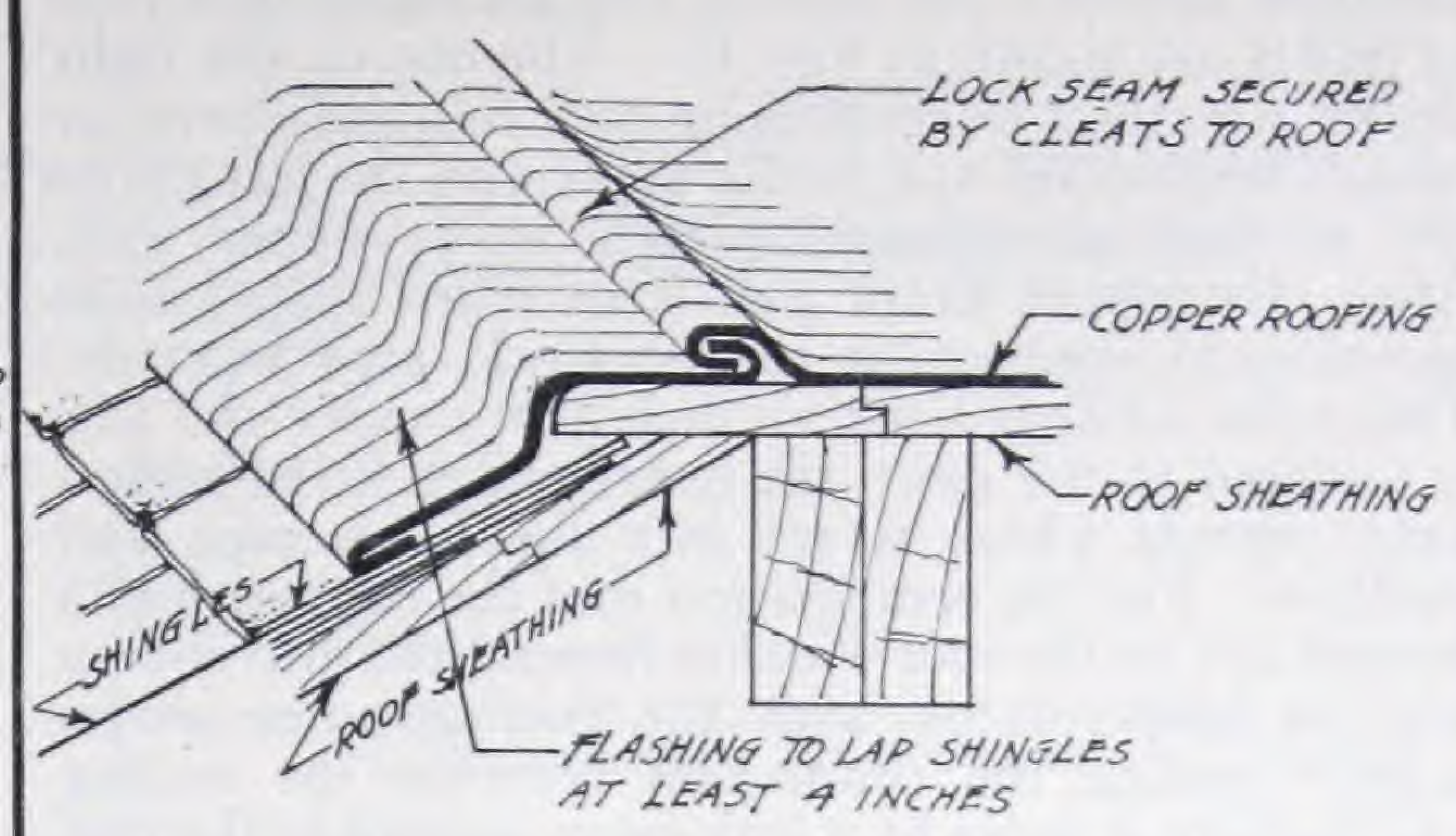
The method shown in the lower left-hand corner requires no special shaping of the ridge-board, and is an excellent way of securing a large ridge roll. The board keeps the metal in place and it is set so that it can be fastened by screws in the ridge-board, making it unnecessary to drill the shingles or slates.

Perhaps the simplest method is to use stock ridge and hip rolls. These are made of hard (cornice temper) copper in sizes up to 3-inch roll and 3½-inch apron. They are fastened by brass screws set through washers into holes drilled in the shingles or located above the upper edge. They require no ridge-board. When these are used the screw-heads should be soldered. On hips small pieces of copper should be built in with the shingle courses to prevent water working under the edge of the apron and thence under the shingles.

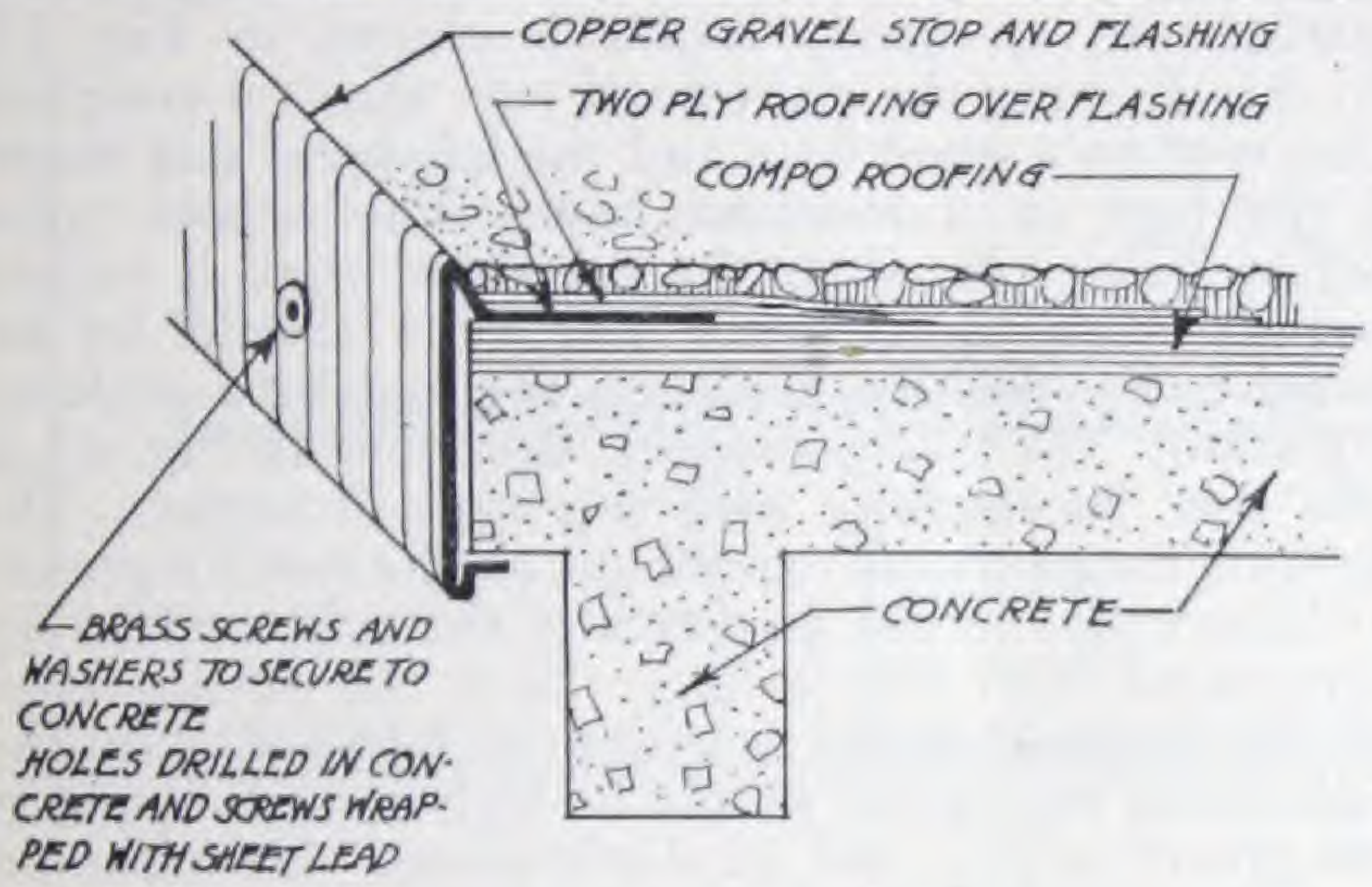
Elaborate ornamented or molded rolls require special bracings and fastenings, and each case should be specially considered.



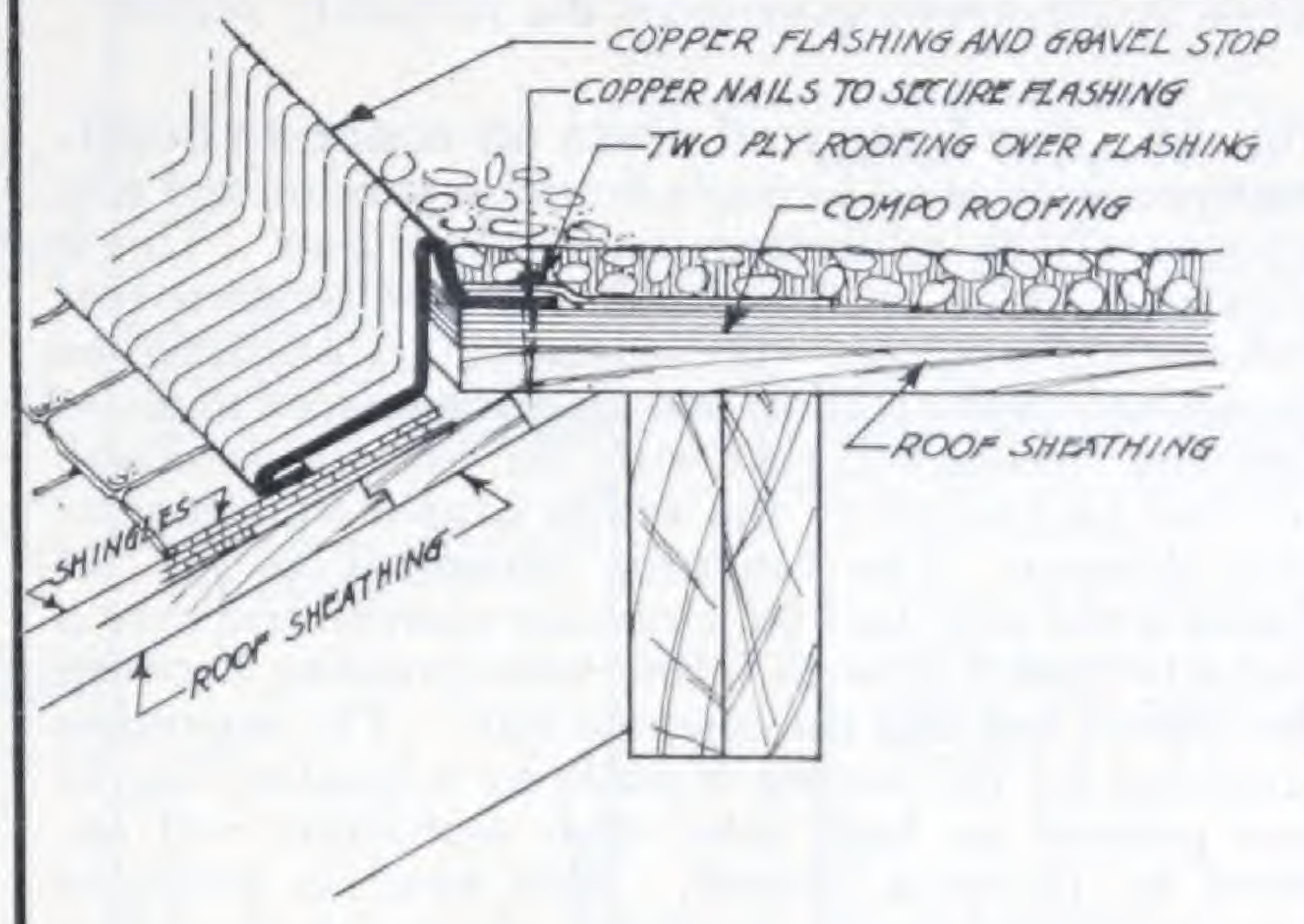
COPPER GRAVEL STOP FOR FLAT COMPOSITION ROOF ON WOOD (37)



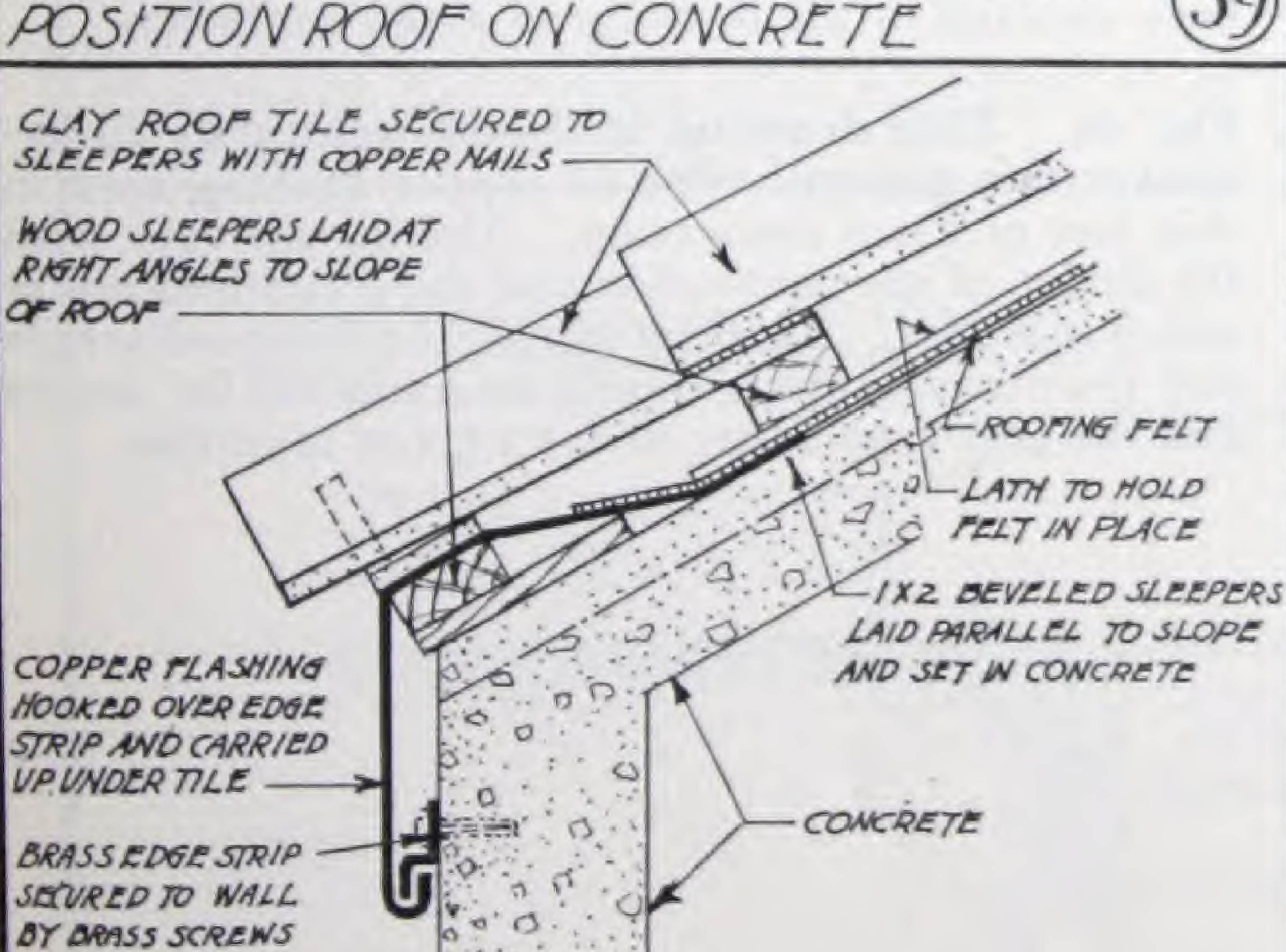
FLASHING FOR EDGE OF COPPER DECK ROOF ABOVE A SLOPING SHINGLE ROOF (38)



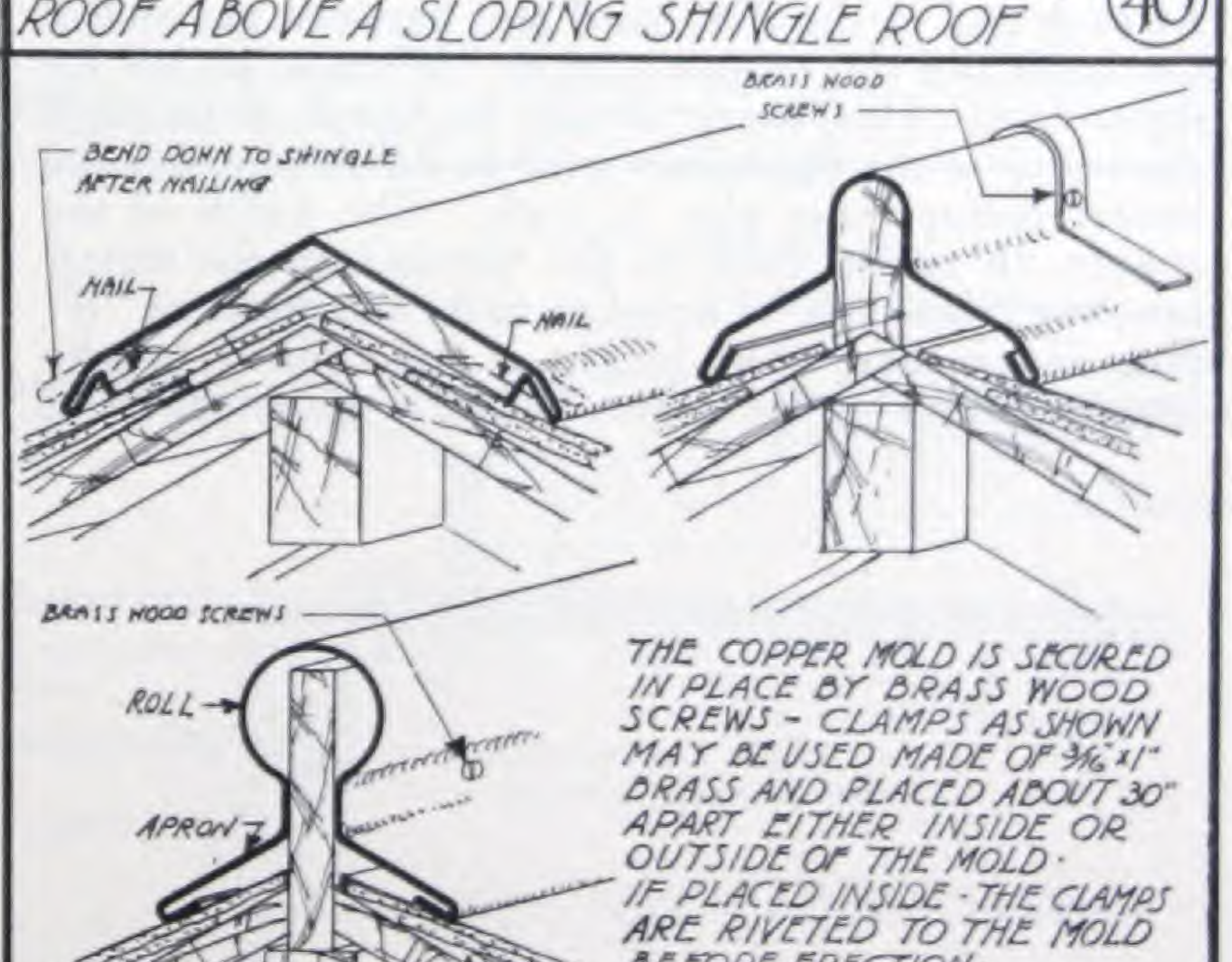
COPPER GRAVEL STOP FOR FLAT COMPOSITION ROOF ON CONCRETE (39)



FLASHING FOR EDGE OF COMPOSITION DECK ROOF ABOVE A SLOPING SHINGLE ROOF (40)



FLASHING AT EAVES FOR A SLOPING TILE ROOF ON CONCRETE (41)



THREE TYPES OF HIP OR RIDGE FLASHING FOR A SHINGLE ROOF (42)

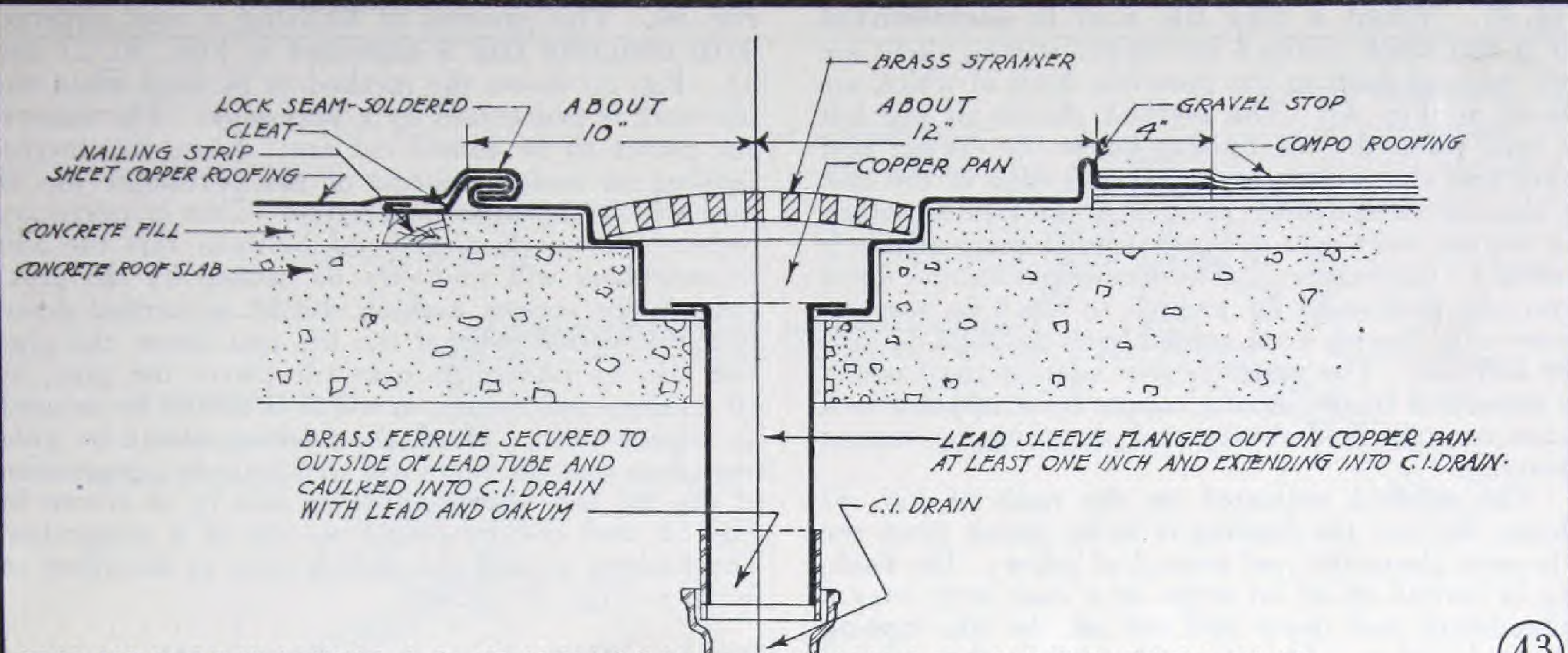
Fig. 43. Two ways of making a water-tight connection between the roofing and an inside iron pipe or leader are shown in Fig. 43. The one on the right shows a method of connecting to a felt-and-gravel or other composition roof, while the one on the left shows the method of connecting to a sheet-copper roof. After the copper drain pan is in place a lead tube (gooseneck) connection to the C. I. pipe is made. This tube is flanged out an inch at its upper end and is soldered to the pan; the lower end is fitted with a brass ferrule which is set into the C. I. pipe and caulked. For the composition roof the copper should extend out on the roof 4 inches beyond the gravel-stop and be incorporated with the roofing. For sheet-copper roofing the connection between the roofing and flashing is made by a lock seam secured to the roof by cleats. This seam is turned in the direction of the flow and soldered. Although the drawing shows one sheet of copper from the gravel-stop and seam to the bottom of the tube, the pan is built up of several pieces. The number and arrangement will vary with each design. To avoid confusion no attempt has been made in the drawing to show the necessary seams.

Fig. 44. For large roof areas on concrete buildings provision must be made for the expansion and contraction of the reinforced-concrete roof slab. This is done by allowing open joints through the concrete roof slab at certain places. These joints must, of course, be recognized in the roofing and an arrangement made so that the roofing will ride with the concrete roof slab and not be broken by the action caused by temperature changes. The condition presented in Fig. 44 shows a tile roof laid on a cement mortar bed over a concrete roof slab with fabric waterproofing between the mortar bed and the concrete slab. The expansion provision for the roofing is made by a band of No. 14 iron painted on both sides with asphaltum and encased in 16-ounce copper. This band is made in lengths convenient for handling; the width should be at least 5½ inches more than the width of the expansion joint in the concrete at the lowest temperature. At each end of the iron band and between the end of the band and the copper a space "B" must be left for expansion. This space should be equal to one-half the width of the expansion joint in the concrete at the lowest temperature plus ¼ inch. The width of the copper, therefore, both on the tile and on the waterproofing fabric will be equal to twice the distance "B" plus 5½ inches. The height is determined by the space required by the mortar bed plus the thickness of the tile. The entire flashing is laid while the fabric waterproofing is being placed or directly afterward, depending on whether it is desired to incorporate the lower flanges of the flashing in the layers of the fabric or place the flashing afterward and cover the flanges with two additional layers of fabric extending out 6 inches on the roof. After the fabric is laid, the mortar bed and the tile are laid. Just before the tile is laid the space between the copper and the cement is filled with mastic-compound and the tile squeezed under the copper and into this compound.

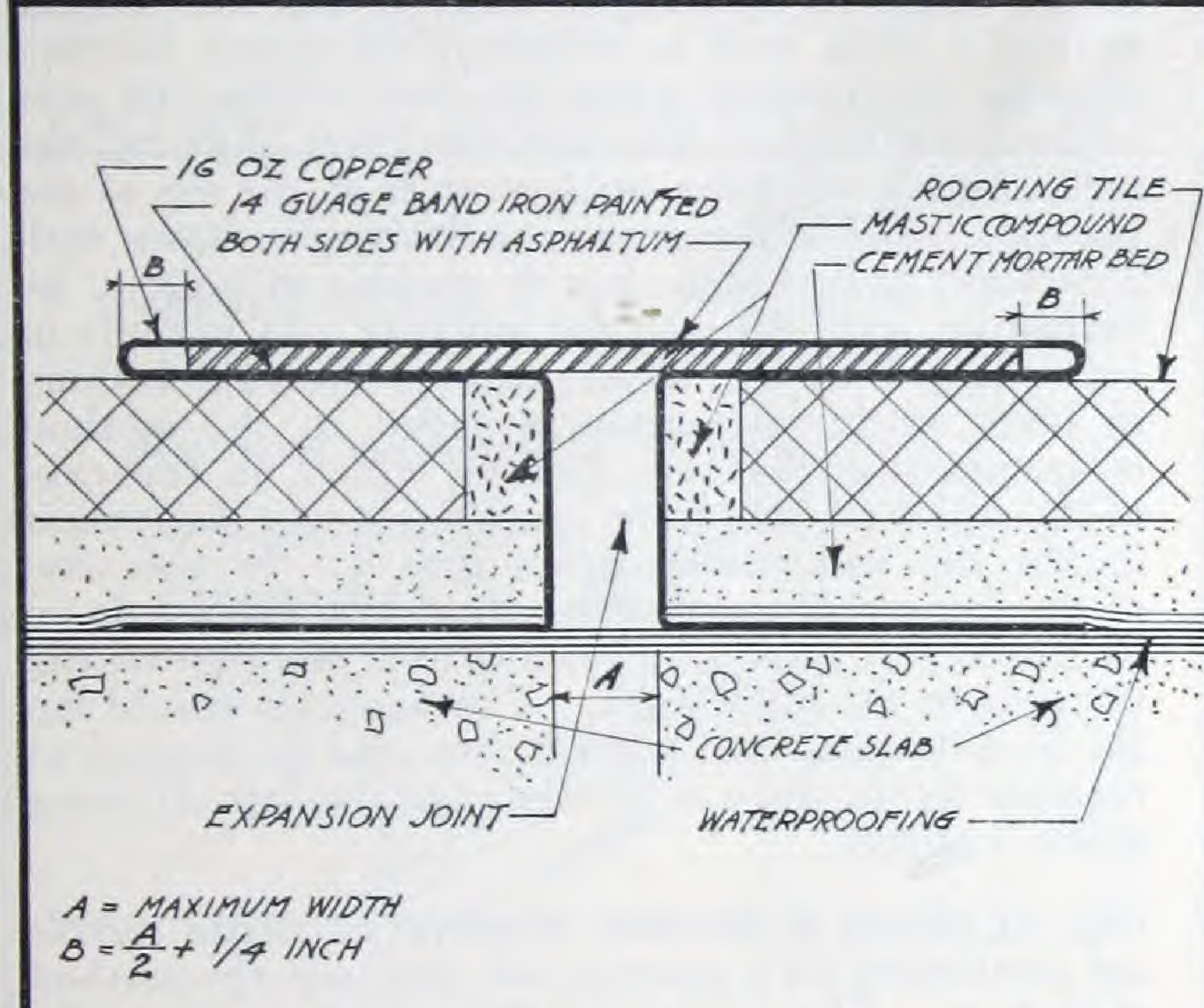
This expansion joint is often made without the iron strip. A copper sheet is shaped roughly as shown in the drawing and is filled with a high-melting-point asphalt. The tile is then set in place. The movement due to temperature changes causes distortion in the flashing strip. The asphalt adjusts itself to take care of this distortion. This method is somewhat cheaper than the one shown but has not the rigidity necessary to resist external wear.

Fig. 45. Another method of connecting a roof surface to an inside leader is shown in Fig. 45. In this drawing the right-hand side shows a composition roof on a wood base and the left-hand side shows a tile roof on a concrete base. The copper tube, before being placed in the cast-iron pipe, is coated heavily with asphaltum. The tube should be secured to the flashing flange on the roof by a soldered lap seam. The lead gooseneck, described in Fig. 43, is also used successfully with this type of outlet. The flashing flange should extend out on the roof a distance at least equal to the diameter of the tube and be incorporated with the roofing. Near the outside edge of the flashing flange a crimp is soldered. In the right-hand example it should be high enough to retain the gravel or slag, and on the left-hand side it should be high enough to finish flush with the top of the tile. The junction of the copper tube and the iron pipe should be carefully caulked, and the opening at the top of the copper tube at the roof provided with a strainer of basket or other design. The strainer has been omitted in the drawing to avoid confusion.

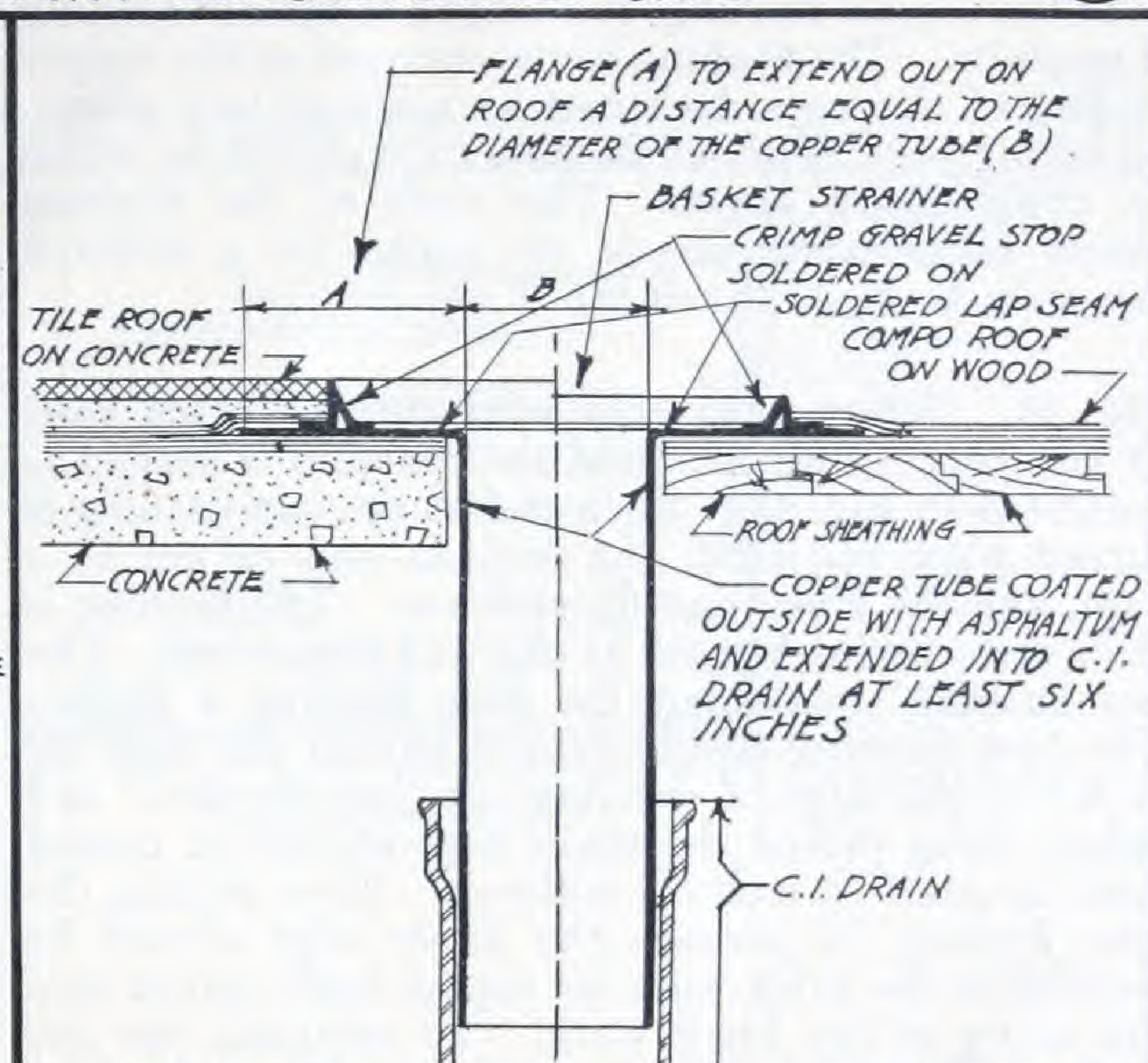
Fig. 46. This drawing is shown primarily to indicate the general type of copper flashing used in this sort of drain connection. The details vary with the design of the connection and the conditions under which it is used. This connection is a patented article and the manufacturers should be consulted for details and the best type to use under a given condition.



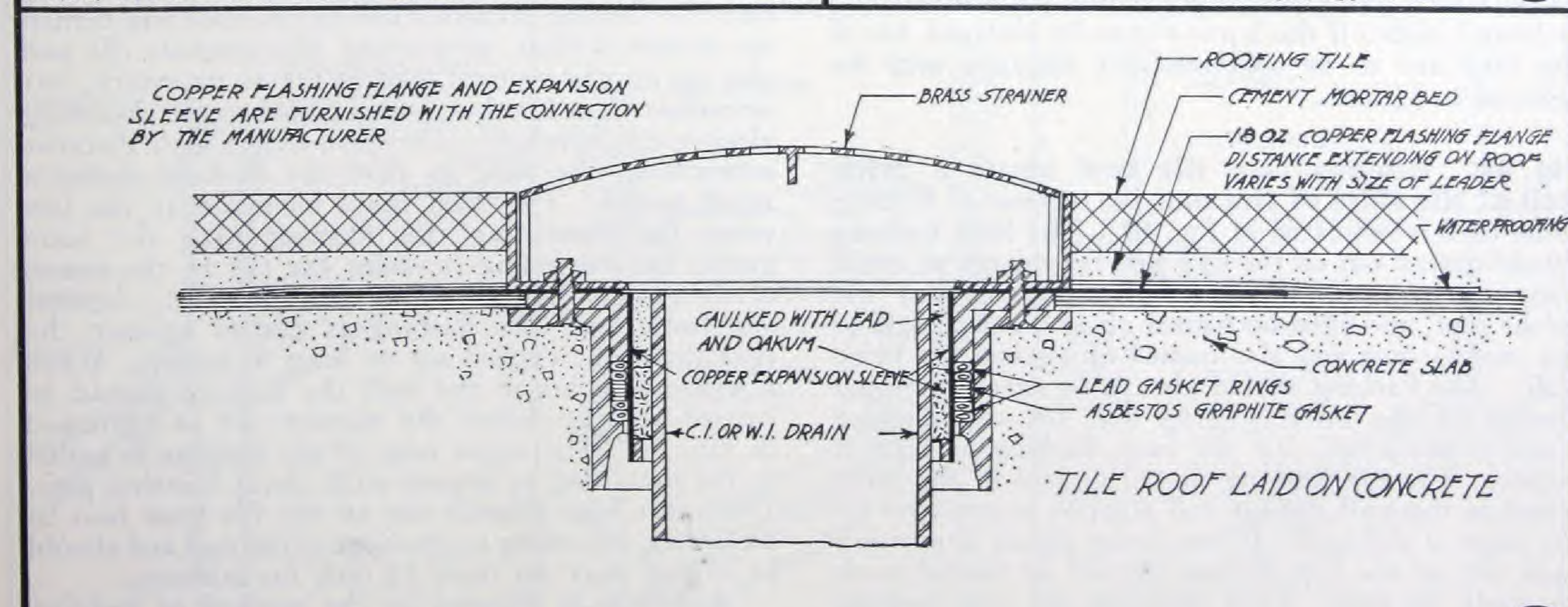
TWO WAYS OF FLASHING A CAST IRON DRAIN THROUGH A CONCRETE ROOF SLAB (43)



FLASHING FOR EXPANSION JOINT OF FLAT TILE ROOF ON CONCRETE (44)



FLASHING FOR A ROOF DRAIN FROM FLAT ROOF COVERED WITH TILE OR COMPO (45)



FLASHING FOR A "HOLT" LEADER CONNECTION (46)

Fig. 47. When a clay tile roof is surmounted by a flat deck covered by copper roofing there are two ways of flashing the junction, both of which are shown in Fig. 47. The method shown on the left is used when the tile finishes below the copper roof level and the roofing laps over the edge of the tile. A clay-tile deck mold is secured to the roof sheathing by copper nails just above a special piece which is called a "top-fixture." The flashing is turned down over the deck-mold far enough to lap 4 inches, the lower edge having been turned back on itself ½ inch for stiffness. The upper or roof edge of the flashing is connected to the roofing copper by a soldered lock seam securely held to the roof sheathing by copper cleats.

The method indicated on the right of Fig. 47 shows the way the flashing is to be placed when the tile ends above the roof instead of below. The flashing is carried up at an angle on a cant strip over a ridge-board and down and out on the tile, lapping about 4 inches. The clay ridge-roll is then placed over the copper flashing, the weight of the roll holding it in place. The flashing is also secured to the copper roofing of the main deck roof by soldered lock seams. In laying both types of flashing care should be taken to avoid sharp angles. The ends of the flashing sheets horizontally should be joined by a soldered lap seam or by a 2-inch lap if not soldered.

Fig. 48. When a clay tile roof abuts a brick wall at the top of the tile roof the junction is flashed as indicated in Fig. 48. Each end of the cap flashing is turned back on itself, the built-in end to act as a dam, and the lower end for stiffness. The flashing is built into the brick work as the wall progresses. The cap flashing should lap the base flashing 4 inches. The base flashing should extend out on the roof tile as far as the edge of the clay tile "top fixture," and before being placed the lower edge should be turned back on itself ½ inch for stiffness. After placing the base flashing in position the upper edge should be secured to the brick work by copper nails driven into the joints of the brick work. To complete the job the cap flashing is then turned down over the base flashing in the usual way. The sheets forming both base flashing and cap flashing should lap horizontally at least 2 inches if the lap is not to be soldered, but if the laps are to be soldered this distance may be reduced to ½ inch.

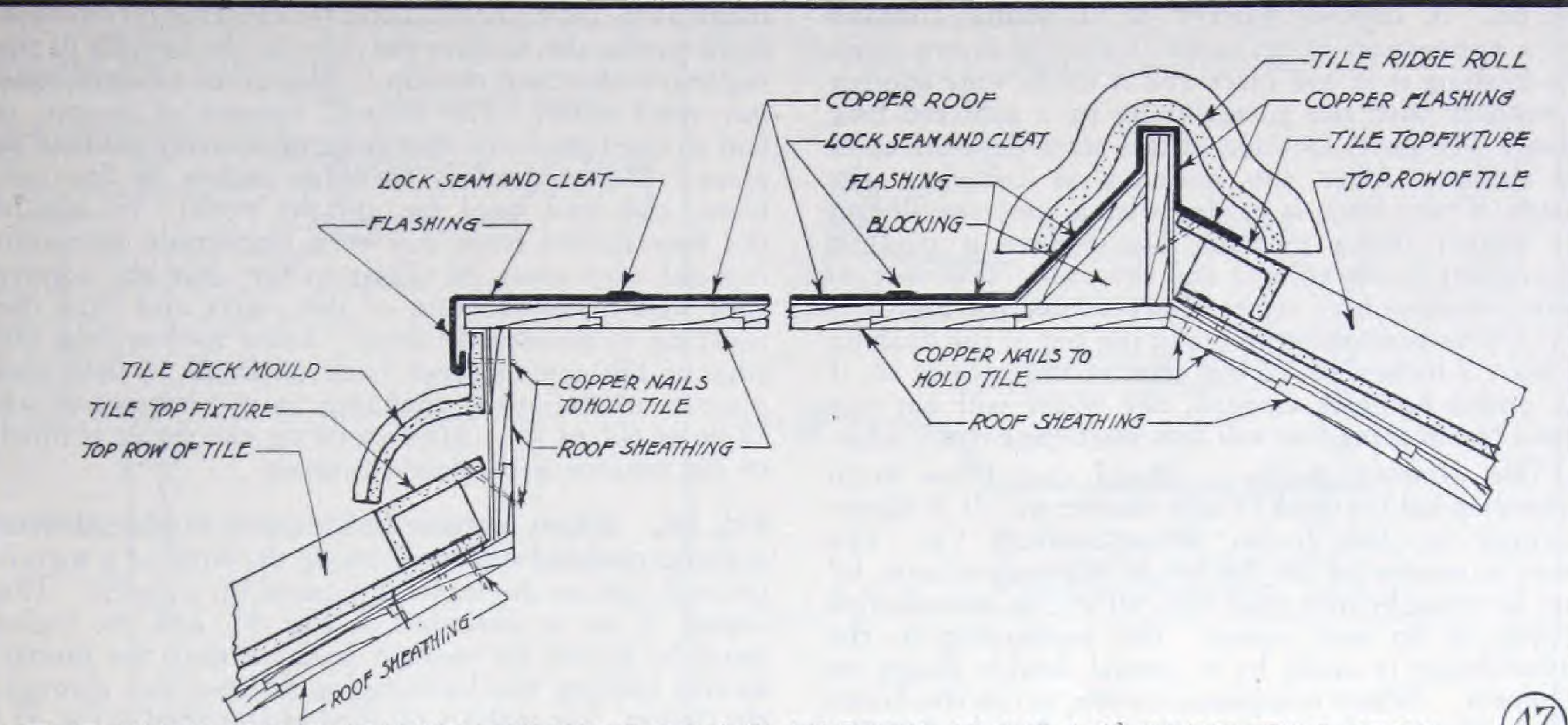
Fig. 49. When a clay tile roof abuts a brick wall at the sides of the roof the method of flashing to be used is indicated in Fig. 49. The base flashing should extend out on the roof just far enough to avoid puncture by the nails used in securing the clay tile to the roof, and then be turned up at a right angle to the roof ¼ inch and also turned up against the brick wall. The flashing should always be carried up high enough on the brick wall so that the cap flashing when in place will lap the base flashing at least 4 inches. The cap flashing should be laid in the brick joints as the wall is built and stepped as required by the slope of the roof. Before being placed in position each end of the cap flashing should be turned back on itself ½ inch. Each sheet of the cap flashing should lap outside the next lower sheet at least 2 inches, but if the lap is to be soldered this distance may be reduced to ½ inch.

Fig. 50. The process of flashing a roof covered with concrete tile is explained in Figs. 50, 51 and 52. Fig. 50 shows the method to be used when the tile work is penetrated by a vent-pipe. The important points to be considered are: First, the careful bedding in cement mortar of the particular tile or tiles which the pipe penetrates. This is necessary because the mechanical bond between this tile and its neighbors will probably be broken by the pipe. Second, the copper flashing should be carried down to and over the edge of the tile just below the pipe and also up under the next tile above the pipe, as far as the wood batten, to which it should be secured by copper nails. Third, the flashing should be wide enough so that the edges will terminate in a depression of the tile and be turned down into it, as shown in Fig. 51, and not terminate on top of a projection. The flashing around the pipe is done as described in detail in Figs. 29 or 30.

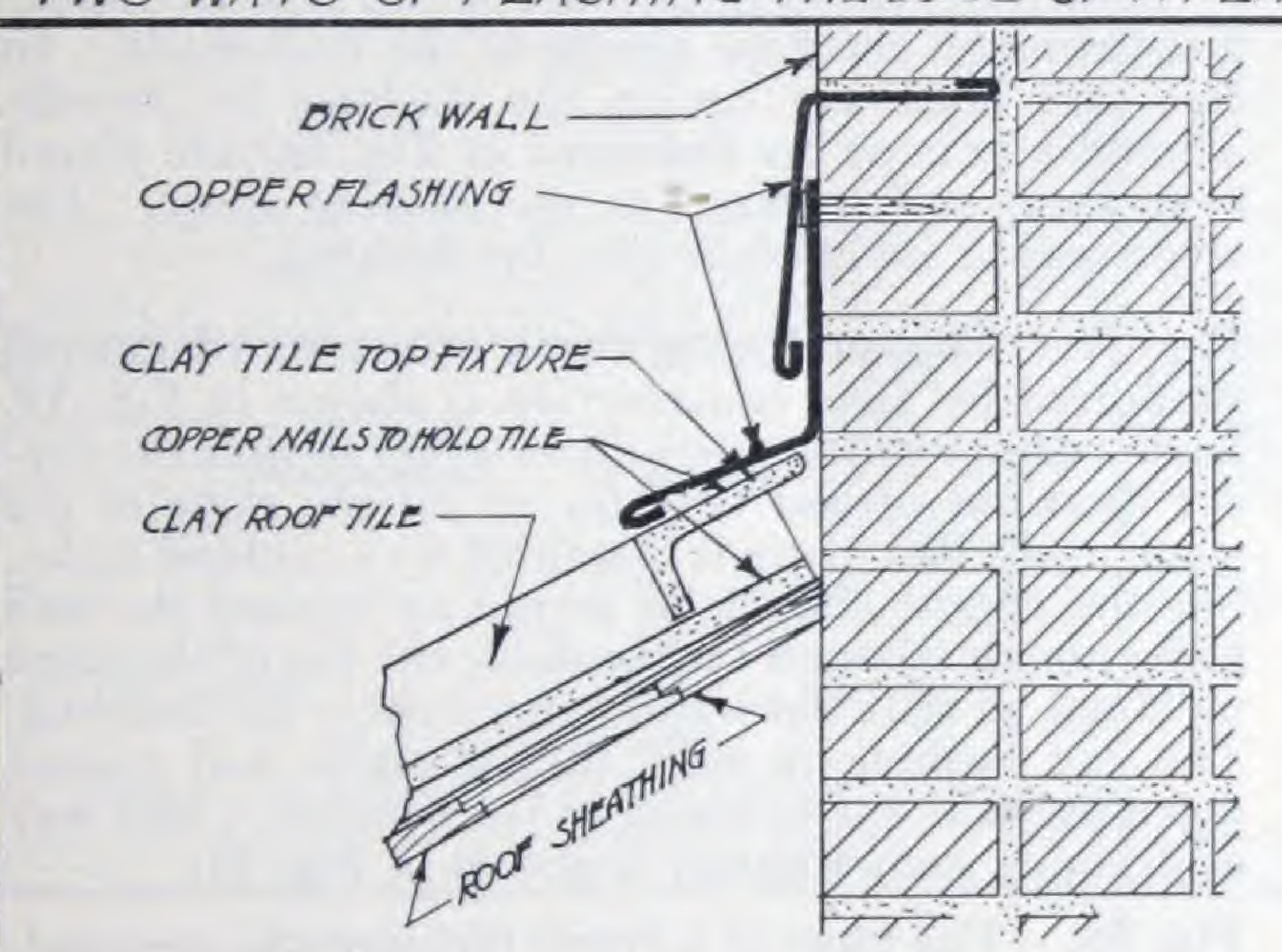
Fig. 51. This drawing indicates the method to be used for flashing a concrete-tile roof ending against a brick wall or chimney, the upper drawing showing the method when the side of the tile roof adjoins the brick work, and the lower showing the method used when the brick work is at the top of the tile roof. For clearness the cap flashing is shown with a straight lower edge, but it should, of course, be turned on itself ½ inch for stiffness. It is built in and stepped in the usual manner for cap flashing in brick work. Attention is called to the method of terminating the base flashing which, in the case of the side wall, should be carried out to a depression in the tile and turned down into it. In the case of the front wall the flashing should be carried down on the roof at least 4 inches and over the edge of the tile next to the brick work. Cap flashings should lap the base flashings at least 4 inches, and be stepped as required by the slope of the roof, and also lap adjoining sheets 2 inches.

Fig. 52 shows a dormer window or other vertical structure on a concrete-tile roof and the method of flashing. The upper part of the drawing shows the flashing against the side wall, and the lower part the flashing against the front wall. In side wall construction the flashing is carried out on the roof and turned up against a cleat supporting the concrete tile and also up on the vertical wall as far as necessary, but never less than 4 inches, and is nailed to the sheathing about every 8 inches. The tile is kept a little distance away from the wall so that the flashing forms a small gutter. Provision must be made at the low point for connecting this flashing with the main gutter by continuing it under the tile to the eaves, or else it must be run out on top of the tile. Against the front wall the flashing is placed against the sheathing and carried up at least 4 inches. When a window occurs in the wall the flashing should be carried well up under the window sill as explained in Fig. 10. The upper edge of the flashing is nailed to the sheathing by copper nails about 8 inches part. The lower edge extends out on the tile from four to six inches, according to the slope of the roof and should be turned back on itself ½ inch for stiffness.

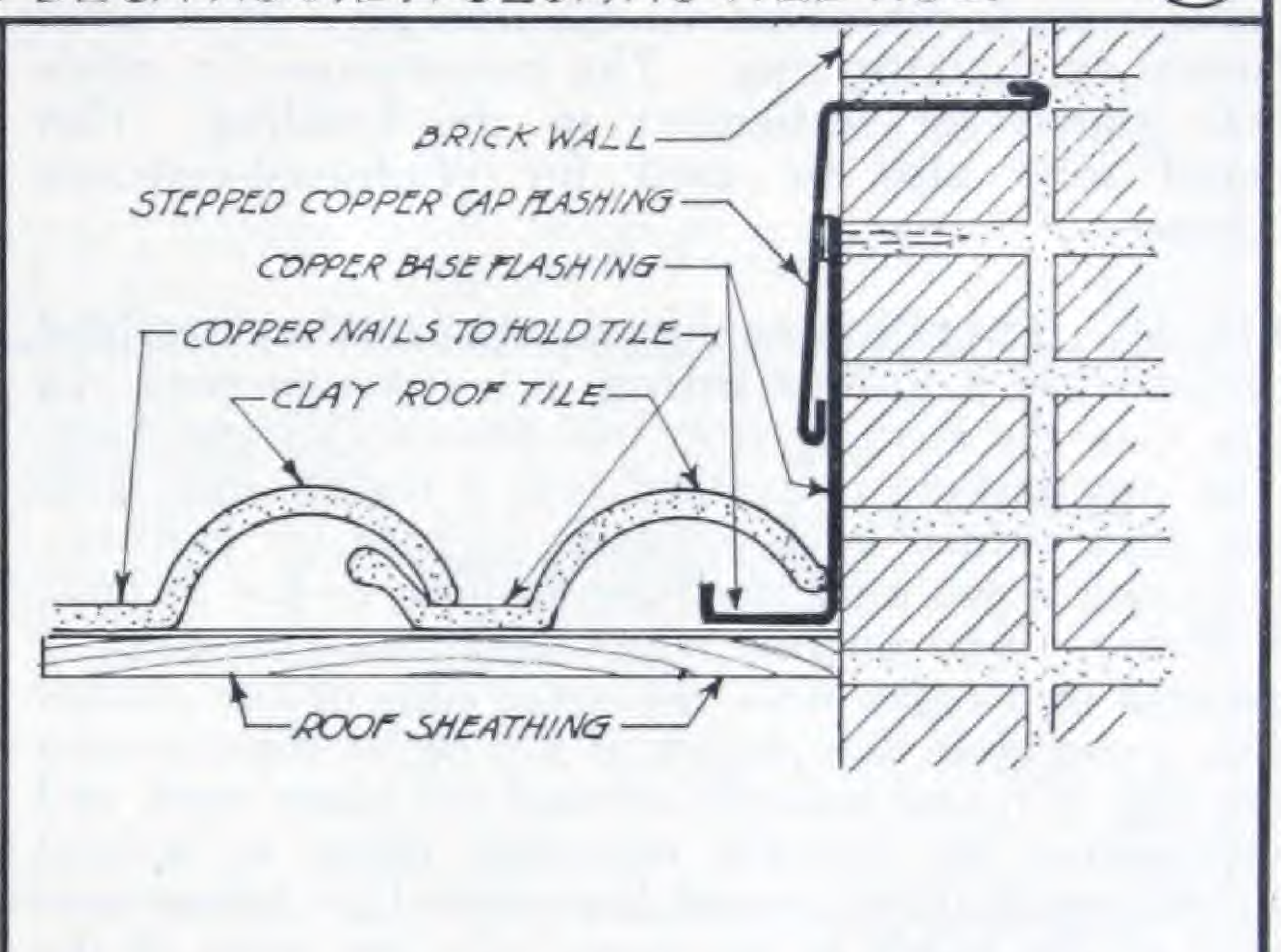
Attention is directed to the method of bedding the tile in cement mortar. This is necessary wherever the tile is cut or wherever water is liable to drive in under the flashing.



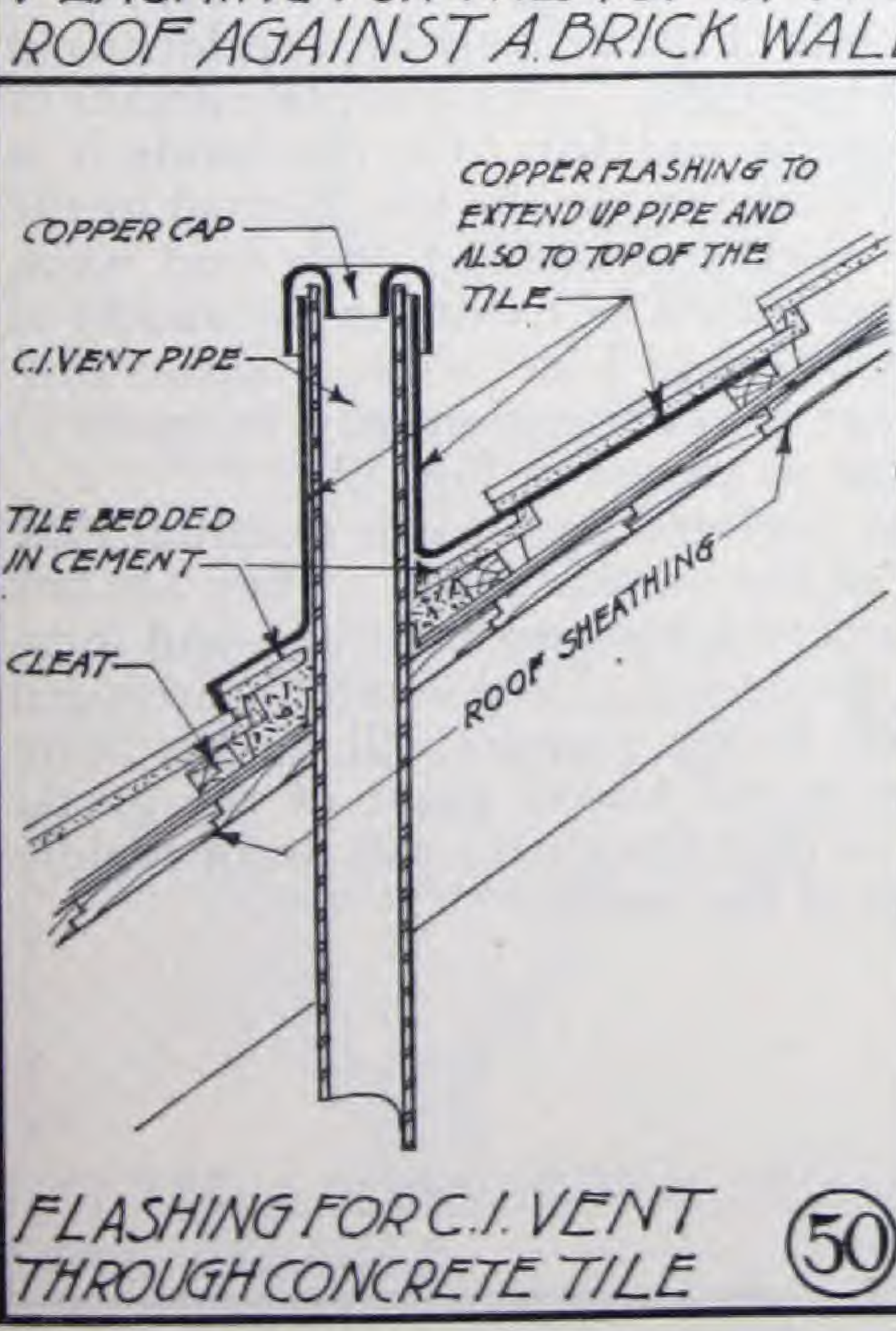
TWO WAYS OF FLASHING THE EDGE OF A FLAT DECK ABOVE A SLOPING TILE ROOF (47)



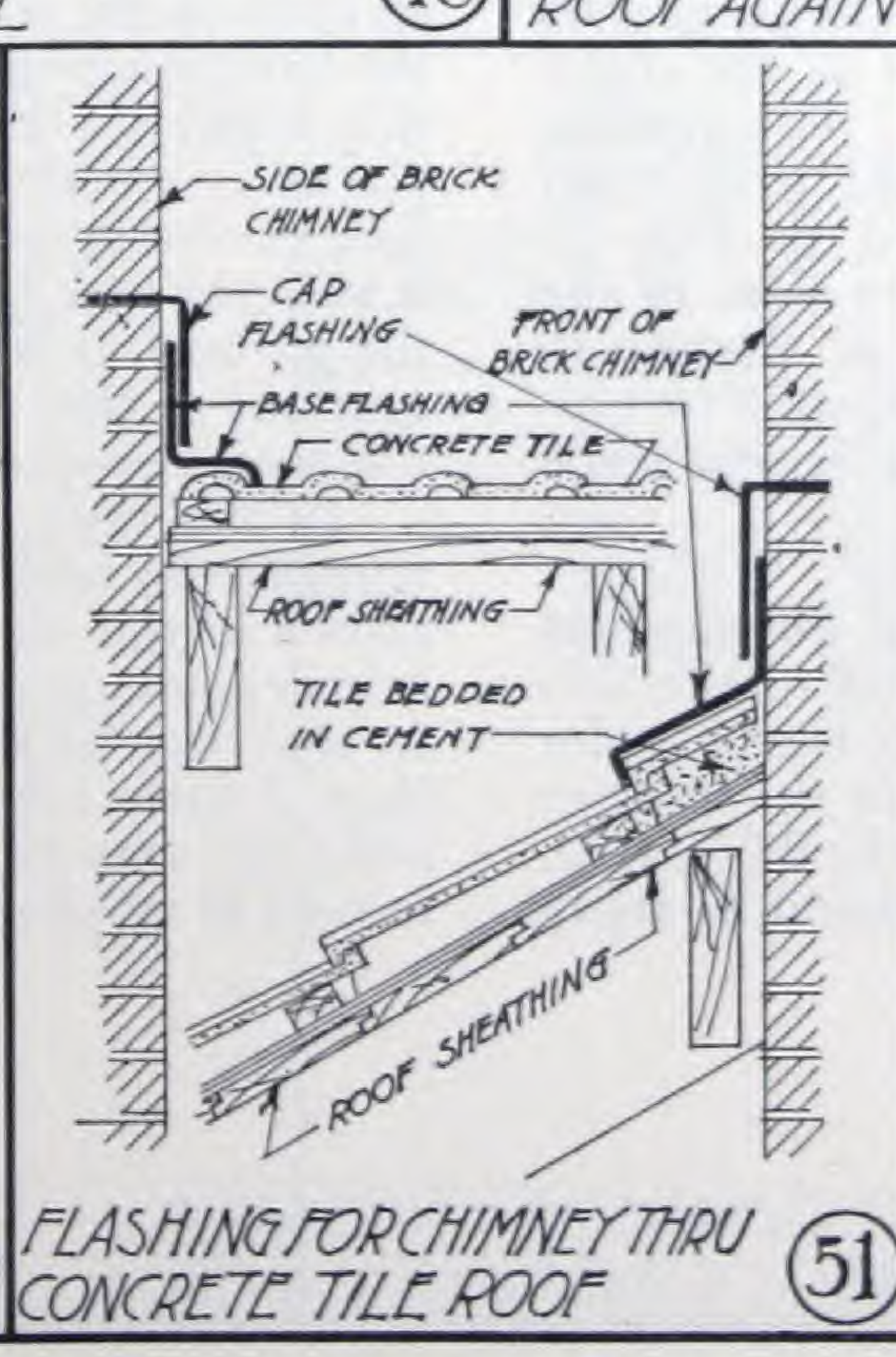
FLASHING FOR THE TOP OF A CLAY TILE ROOF AGAINST A BRICK WALL (48)



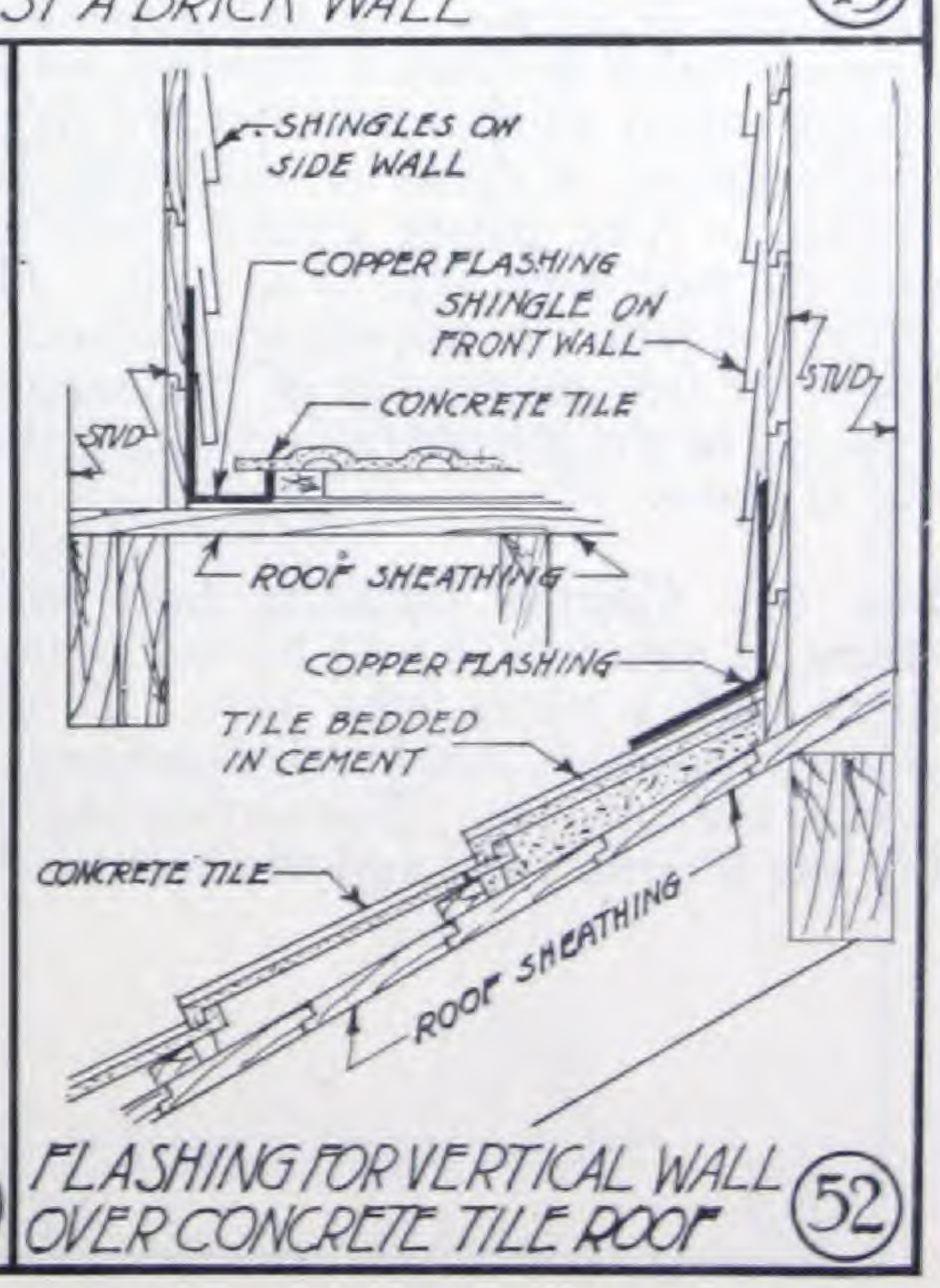
FLASHING FOR THE SIDE OF A CLAY TILE ROOF AGAINST A BRICK WALL (49)



FLASHING FOR C.I. VENT THROUGH CONCRETE TILE (50)



FLASHING FOR CHIMNEY THRU CONCRETE TILE ROOF (51)



FLASHING FOR VERTICAL WALL OVER CONCRETE TILE ROOF (52)

Fig. 53. A copper gutter in a stone cornice and a connection to an inside leader is shown here. The flashing is in one piece and is made wide enough to connect with the gutter-lining by a soldered lock seam. The exact location of this seam depends upon the design. After the masonry is complete the gutter, if very long, is graded with a concrete fill and the copper lining placed. The copper is caulked into reglets in the cornice and the wall. (For a complete description of reglet construction see Fig. 55.) It is a wise precaution to make the top of the flashing at least 3 inches above the edge of the cornice so, if the outlet becomes clogged, the water will not rise above the flashing but will flow over the cornice edge.

The drawing shows a special cast brass drain recommended for work of this character. It is manufactured by the Josam Manufacturing Co. The drain is connected to the house drainage-system by cast or wrought-iron pipe with all angles turned with fittings of an easy curve. The connection to the gutter-lining is made by a special double flange on the drain. Where it is impracticable to run the drain-pipe as close to the gutter as shown, a long lead goose-neck is used, connected to the iron pipe by a brass ferrule or caulking ring. The construction in either case allows for settlement in the building. This detail may also be used for reinforced-concrete cornices.

Fig. 54. This illustration shows another method of forming a gutter-lining in a stone cornice. In this case the flashing is in two pieces, cap and base. The cap flashing is caulked into a reglet, and, with the edge turned back on itself ½ inch for stiffness, is turned down over the base flashing to lap at least 4 inches. The outside edge of the base flashing is secured in a reglet near the outer edge of the cornice (for a complete description of the reglet construction see Fig. 55), and brought around the stone work and up against the parapet masonry, where it is held by the cap flashing turned down over it. About midway of the width of the gutter the two parts of the lining should be joined by a soldered flat-lock seam. In wide gutters (over 2 feet) this is secured to the sheathing by cleats. In exceptionally large gutters it is advisable to form a standing seam at the reglet for expansion as shown in detail "A." The grading of the gutter is done by sheathing laid over wood blocking. The gutter outlet described in Fig. 53 may be used with Fig. 54 as well. The sides of the gutter should be sloped somewhat, as shown, to allow for free movement of the copper, and to prevent ice in the gutter from pushing the corona stone out of place.

Fig. 55. Copper flashing laid over or against stone or concrete should be well secured to the masonry with a water-tight joint. To do this a reglet about 1 inch wide and 1 inch deep is cut in the stone or cast in the concrete. The surface edge should be true, but the interior sides and the bottom should be fairly rough as thereby a better bond for caulking is obtained. Some prefer also to flare the sides so the bottom of the reglet is wider than the top. This gives a better bond but costs more. The copper, formed as shown, is laid to the bottom of this cut and securely caulked in place. Molten lead is used for reglets in flat surfaces, and lead wool for upright work. To obtain the best results from this very important operation especial care must be taken to see that the copper goes well to the bottom of the reglet and that the caulking is thoroughly done. Some roofers fold the edge of the copper sheet back on itself ½ inch and place it in the reglet inclining to the bottom at an angle of 60° or so. After caulking the reglet is filled to the surface with elastic cement.

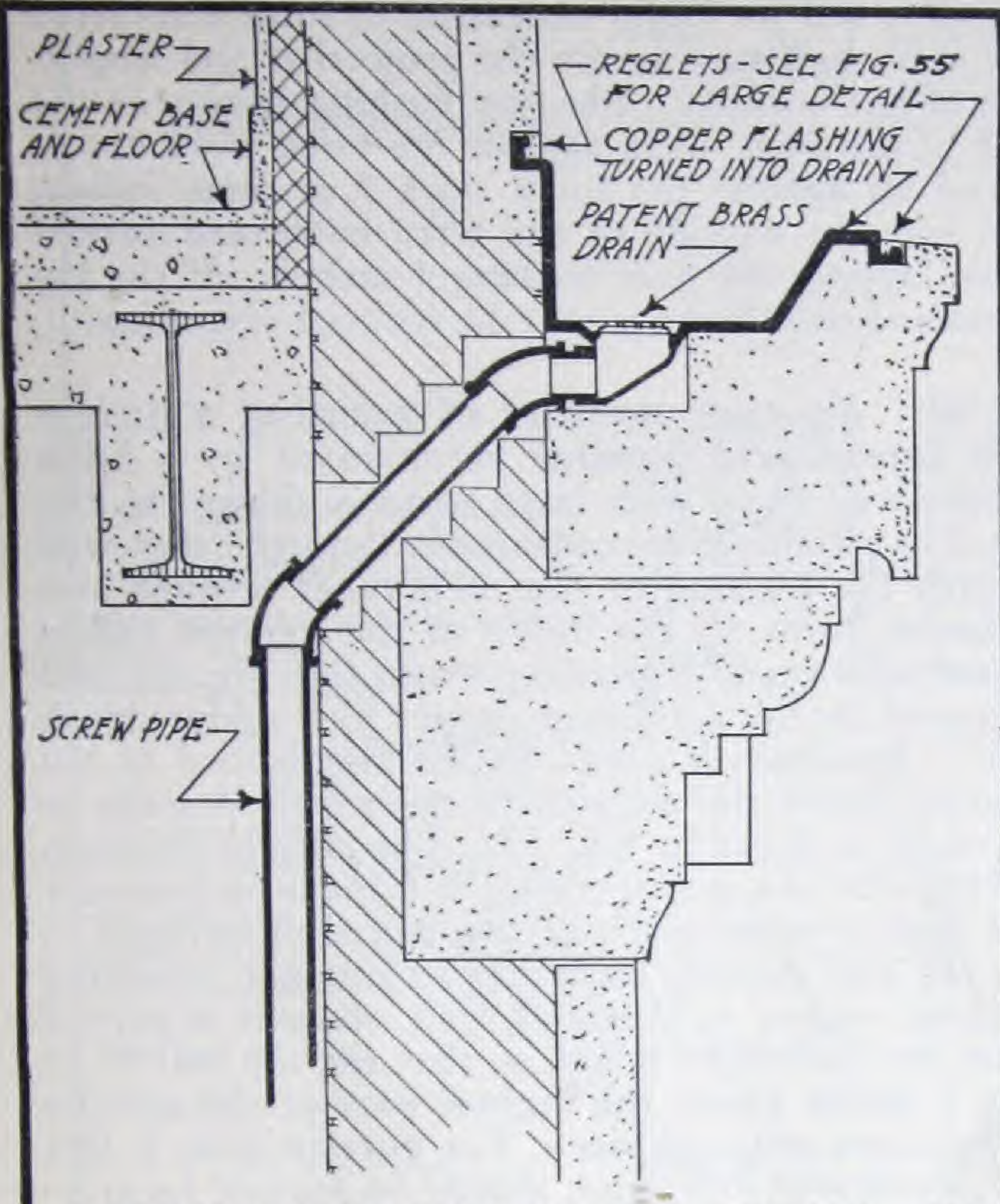
Fig. 56. When a stone balustrade is placed over a stone molded course forming the front of a metal-covered surface the metal is secured by a reglet. The copper is set as described in Fig. 55, and the reglet must be placed far enough back so that the bronze dowels holding the balustrades will not cut through the copper. The reglet is caulked as described in Fig. 55.

Sometimes the flashing must be run as a continuous piece through the base course of the balustrade. In this case holes are cut in the flashing for dowels. Thimbles or caps (as described in Fig. 66) are placed over them and soldered to the flashing sheet. The stone is then set in place over the flashing.

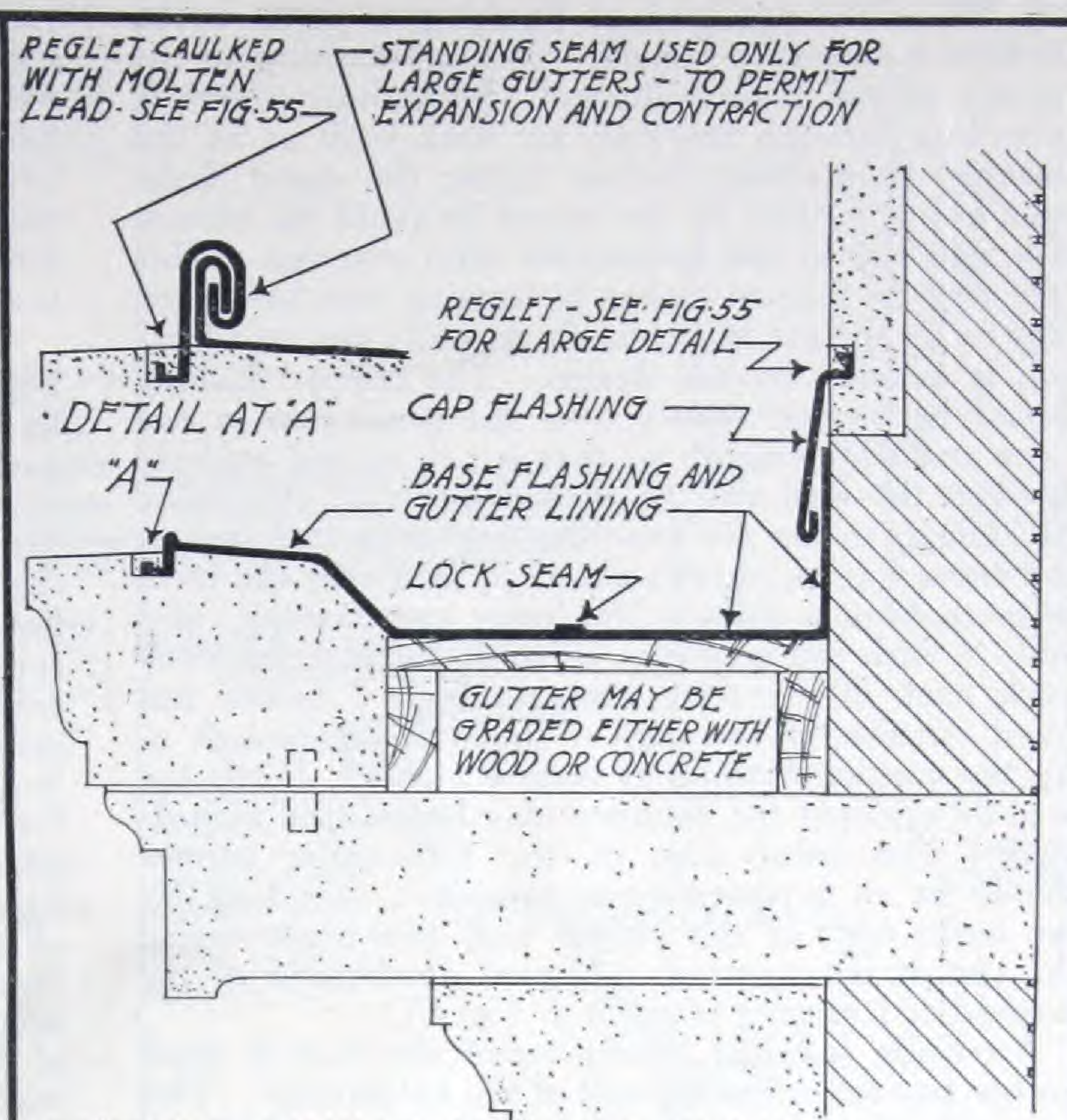
Fig. 57. Copper lining for a stone band-course supported by steel construction is shown in Fig. 57. Such a course collects very little water so that the copper need not extend very far up on the slope of the stone to the line where it is secured by a caulked reglet, but the copper should be turned up against the wall high enough (about 4 inches above the top of the stone molding) so that the water cannot enter the building. The cap flashing is built into a reglet and turned down over the gutter-lining to lap 4 inches. One way of draining such a gutter is shown in Fig. 53.

Fig. 58. The base of a stone balustrade surrounding a balcony or similar projection should be flashed with copper as indicated in Fig. 58. The copper is secured on the outside of the balcony by a reglet cut in the base below the balusters. (For complete details of this reglet see Figs. 55 and 56). On the inside it is placed in a reglet, as shown on the left, formed in the face of the stone work and caulked with lead wool. A soldered lock seam should be formed in the middle of the gutter if it is more than 2 feet wide. Gutter connections in this type of construction may be made to the drainage-system as shown in Fig. 53.

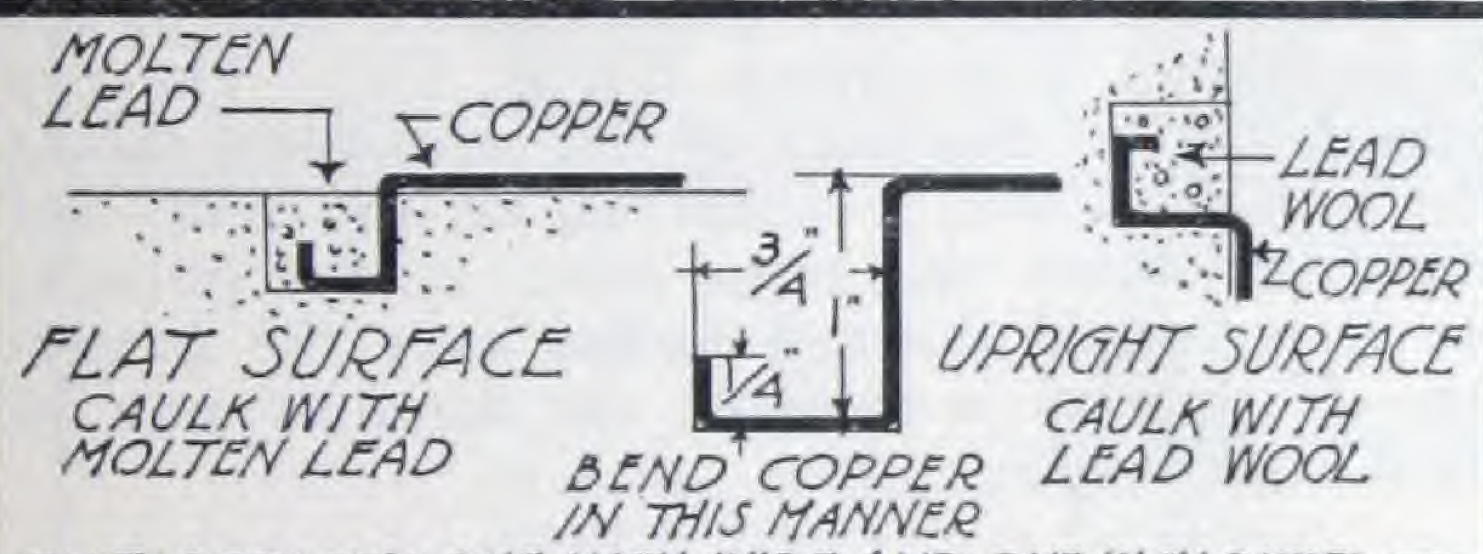
In this type of enclosed gutter it is essential that scuppers be built in the outside faces. They are not shown in the illustration because their size and location depend upon the design. They should be arranged so that the bottom of the scupper will be not more than 2 inches above the lowest point of the gutter and large enough so that the gutter will drain rapidly in case of stoppage of the outlet.



GUTTER AND OUTLET FOR STONE CORNICE WITH INSIDE DRAINAGE (53)

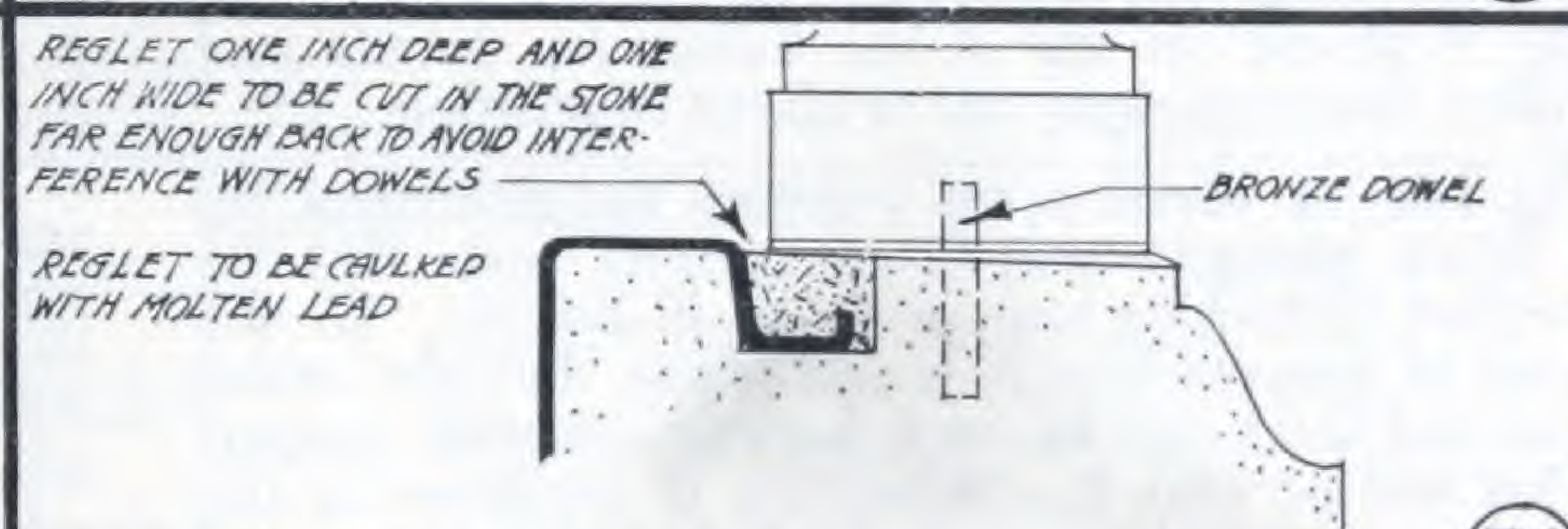


GUTTER LINING AND CAP FLASHING FOR A STONE CORNICE (54)

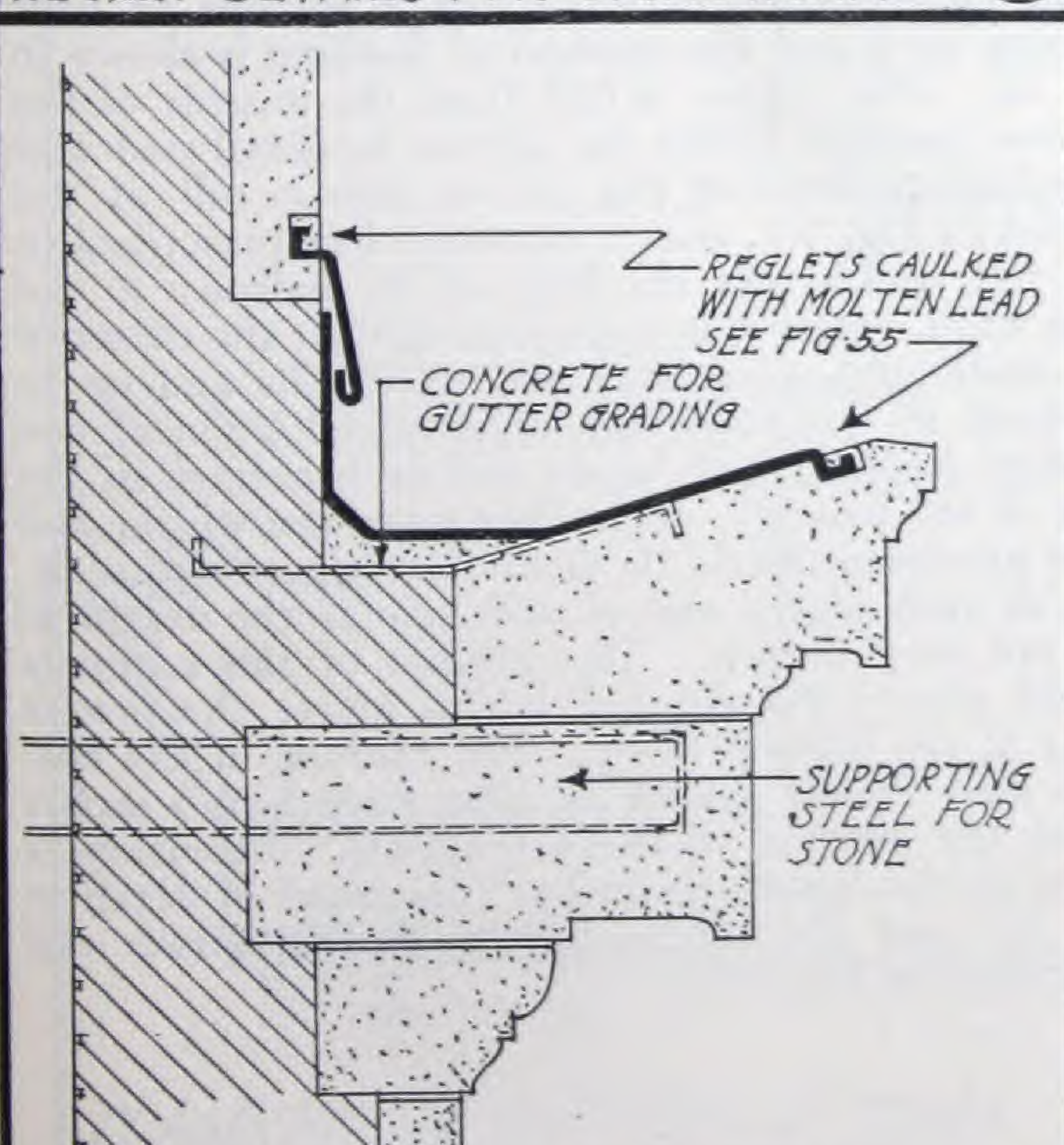


CUT REGLETS ONE INCH WIDE AND ONE INCH DEEP

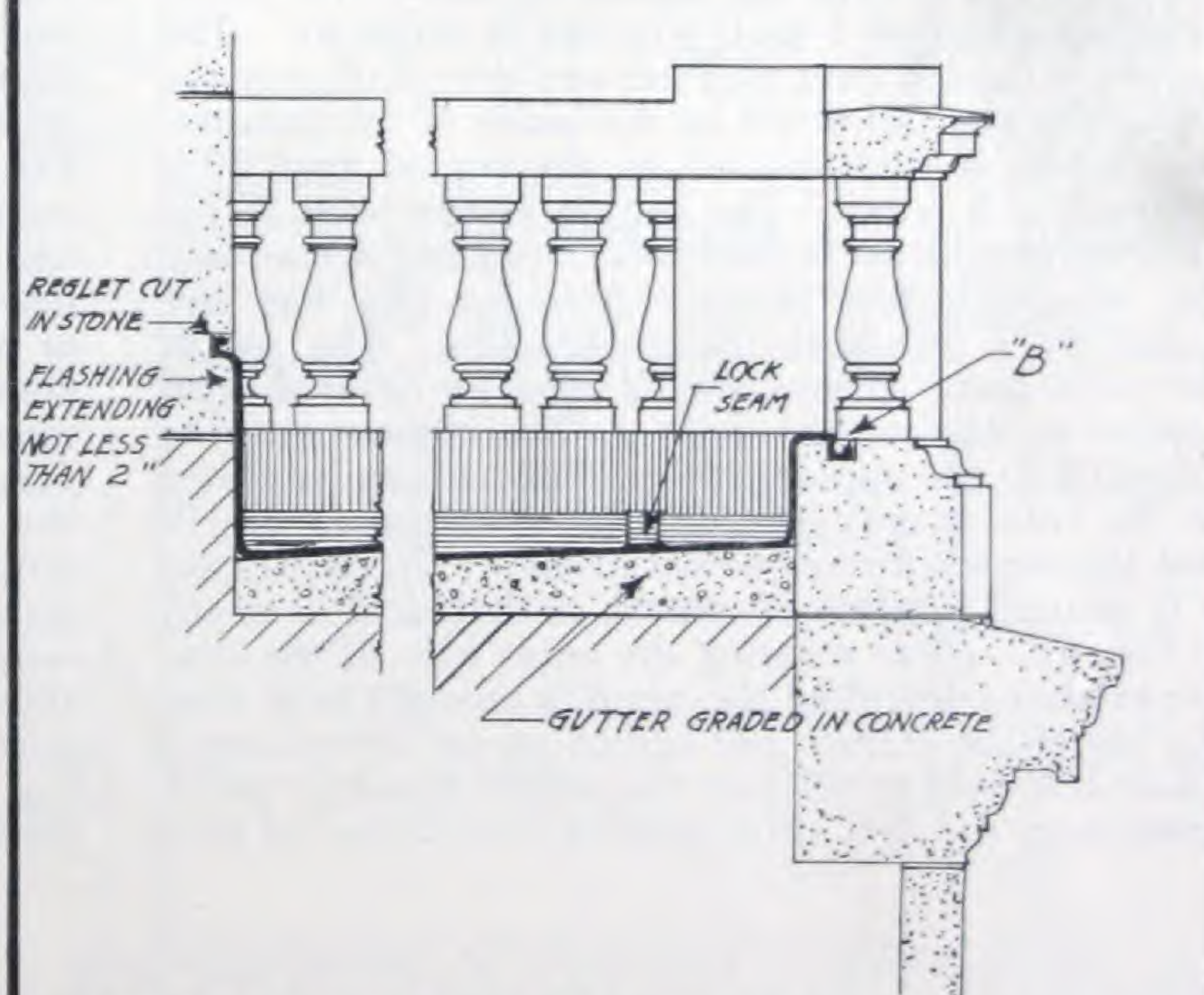
REGLET DETAILS FOR STONE WORK (55)



DETAIL AT "B" FIG. 58 (56)



GUTTER LINING FOR A STONE BAND COURSE (57)



GUTTER LINING IN CONNECTION WITH STONE BALUSTRADE (58)

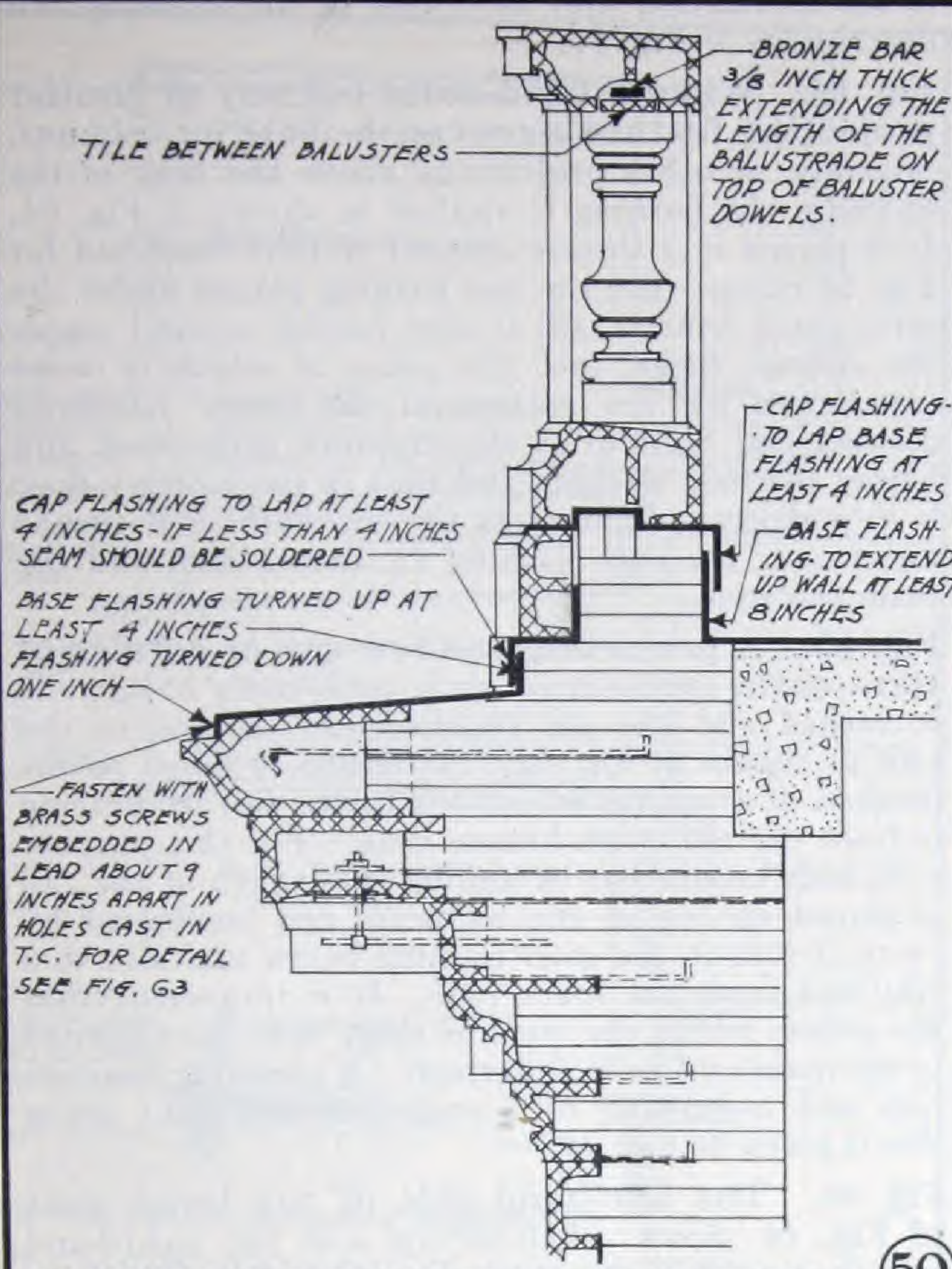
Fig. 59. One method of flashing a terra-cotta cornice is shown in Fig. 59. The cap flashing on the outside of the balustrade and the flashing above it extending through the wall are both built in as the masonry progresses. Before laying the upper flashing a key is formed by the mason to avoid the chance of a side slip in the balustrade after erection. This key may be formed either by setting two bricks on edge or by the use of concrete; its exact size and location is decided by the design. The copper flashing should be formed closely over the projection in one piece and wide enough so that it can extend entirely through the wall and be turned down on the inside far enough to lap the base flashing at least 4 inches, and turned down outside about ½ inch over the terra cotta to form a drip. The lower cap flashing, also built in with the masonry, turns up against the brick work back of the terra cotta at least 3 inches and down outside on the face of the wall far enough to lap the cornice flashing at least 4 inches. If the lap is to be soldered the distance may be reduced accordingly. The outer edge of the terra-cotta cornice should be so designed as to provide a fastening for the outer edge of the copper base flashing covering the top of the cornice. (A good description of the method of fastening is given in Fig. 63.)

Attention is called to the use of the ⅜-inch thick bronze bar set in the top rail of the balustrade. This bar is continuous on top of the balusters, and if possible should be returned at the ends of the balustrade into the main wall of the building and anchored. The bar is placed on top of the balustrade dowels just before the terra-cotta rail is placed in position.

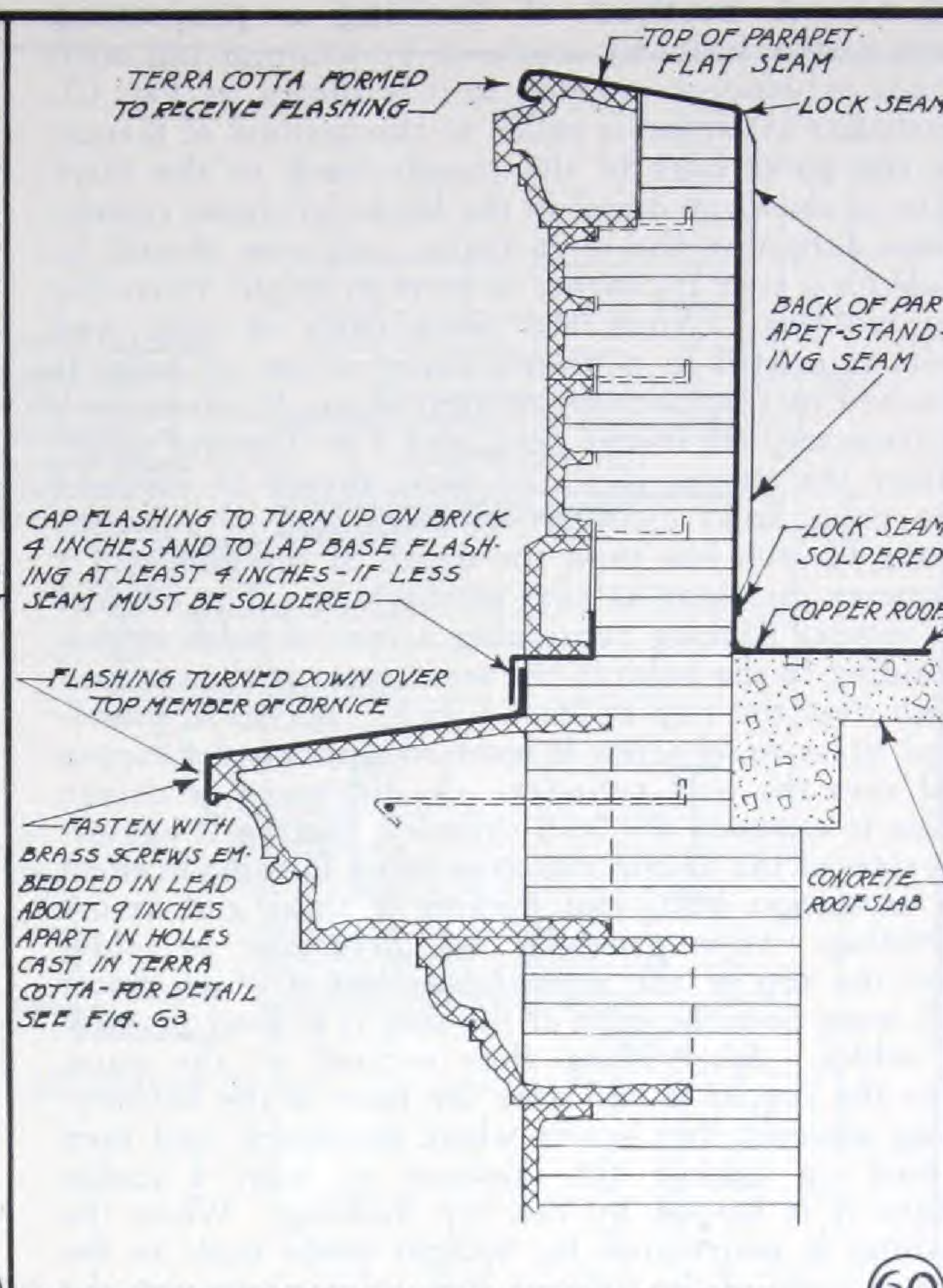
Fig. 60. A terra-cotta cornice surmounted by a brick parapet-wall faced by terra cotta and the method of flashing same is shown in Fig. 60. In this type of construction it is important that the entire top and back of the wall be covered with copper. This will prevent the absorption of moisture by the masonry through the joints of the terra cotta and brick work and permit cutting down the width of the terra-cotta cap. In designing the terra-cotta cap the upper part of the cap should be made with a roll, as indicated, from 1 to 1½ inches in diameter. The copper is formed over this roll and extended over the top of the cap and down on the inside of the parapet-wall where it is connected to the copper roof by a soldered lock seam. The copper at the back of the parapet should be formed with standing seams and the top with flat seams soldered. The two are joined by a lock seam hammered flat. The top of the terra-cotta cornice should also be covered with copper to protect the joints. The copper may be formed over the upper member of the cornice as shown or the cornice may be designed as shown in Fig.59 and the copper formed over this step. In either case it is secured in place by screws as described in detail in Fig. 63. After securing the outer edge of the copper as above described the metal is brought back over the top of the cornice and turned up on the masonry. There it is held in place by the copper flashing turned down over it. For cornices with over 2 feet of projection it will be found expedient to form a soldered lock seam half way across the projection and lengthwise of the cornice. The cap flashing begins at the back of the terra cotta against the brick work and is turned up against the brick work 3 or more inches, then brought outside of the terra cotta and turned down, lapping the base flashing 4 inches. If the lap is soldered this distance may be reduced accordingly.

Fig. 61. Another method of forming a gutter in a terra-cotta cornice surmounted by a brick parapet-wall faced with terra cotta is shown in Fig. 61. The flashing is continued through the wall beneath the terra-cotta cap to prevent seepage and continues down on the inside of the parapet and is formed with vertical standing seams (see Fig. 60) and connected to the main roof copper by a soldered lock seam. Attention is called to the key formed in the masonry below the terra-cotta cap which is made as described in detail in Fig. 59. The cornice flashing, forming also the gutter-lining, is formed on its outer edge over a terra-cotta roll (as described in detail in Fig. 60) and extends back on the masonry, avoiding all sharp angles, to the brick wall where it is turned up on the wall high enough so that the top will be at least 3 inches above the highest part of the outside of the terra-cotta cornice. For gutters over 2 feet wide a soldered lock seam should be formed longitudinally in the middle of gutter. This seam is secured by cleats nailed to wood strips set in the concrete. (A method of connecting a gutter of this type to the drainage-system is described in Fig. 53.) The cap flashing is laid at the back of the terra-cotta facing of the parapet about 3 inches up on the wall, and extends out under the terra cotta to the outside, where it is turned down 4 inches over the gutter-lining. If this lap is soldered the distance may be reduced accordingly.

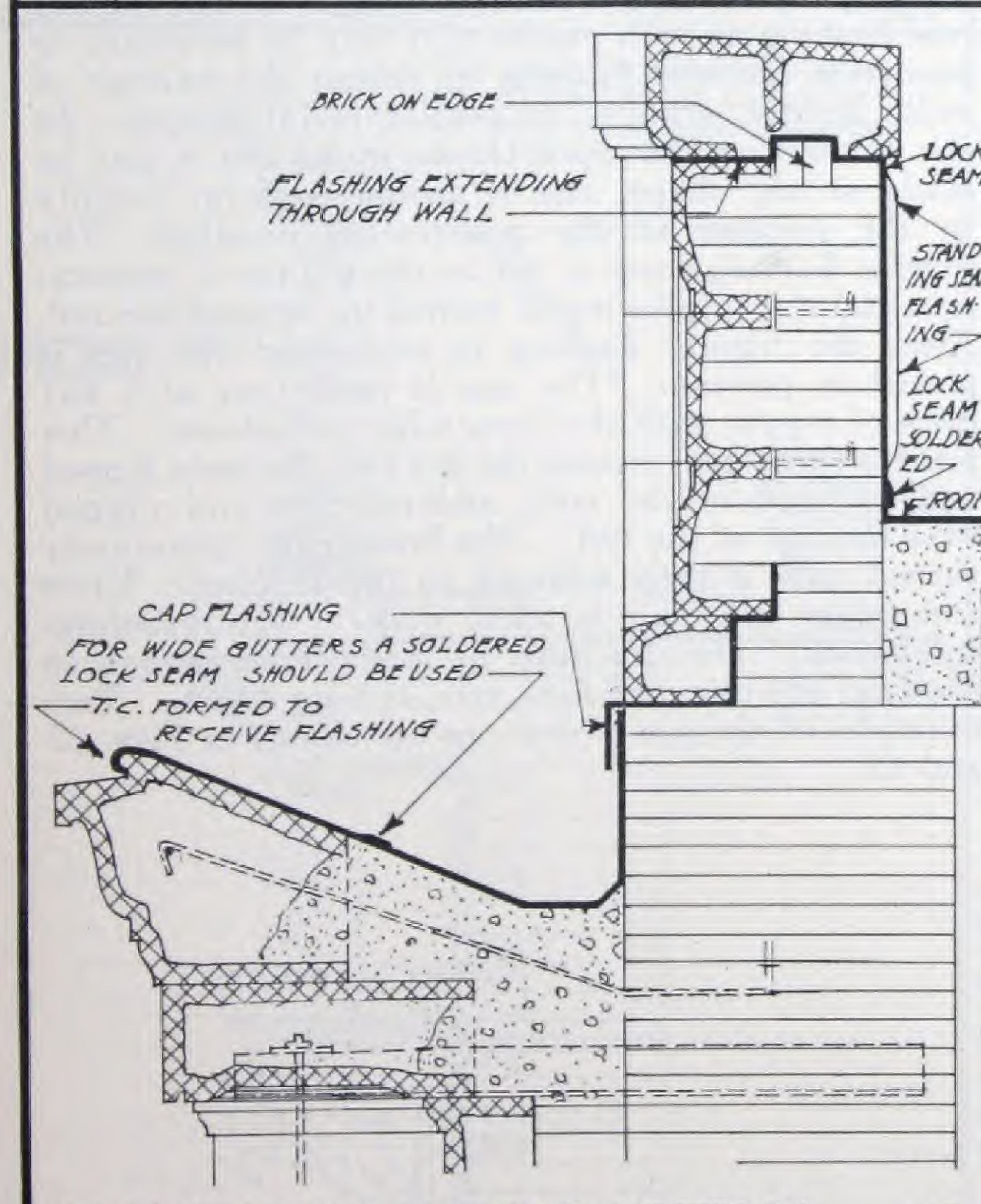
Fig. 62. A balcony formed of terra cotta with a rail of the same material and a window or door opening to it and the method of flashing is shown in Fig. 62. The copper is laid from the outside of the cornice (secured either by screws as illustrated and described in detail in Fig. 63, or over a roll as described in Fig. 60), over a masonry key (described in Fig. 59), and across the floor of the balcony to the main walls, where it is turned up against the masonry and under the terra-cotta and wood sills and up to the back of the wood sill. The introduction of one or more soldered lock seams will be necessary in the floor of the balcony, depending upon the width, and some provision should be made for copper-lined scuppers at such places and of such size as the design of the rail may permit. The bottom of the scuppers should always be about 2 inches above the lowest point of the balcony floor. The flashing of the balcony floor should rise on all sides from 2 to 3 inches above the bottom of these scuppers. Attention is called to the copper water-bar (described in detail in Fig. 11) and the bronze bar in the balustrade rail (described in Fig. 59).



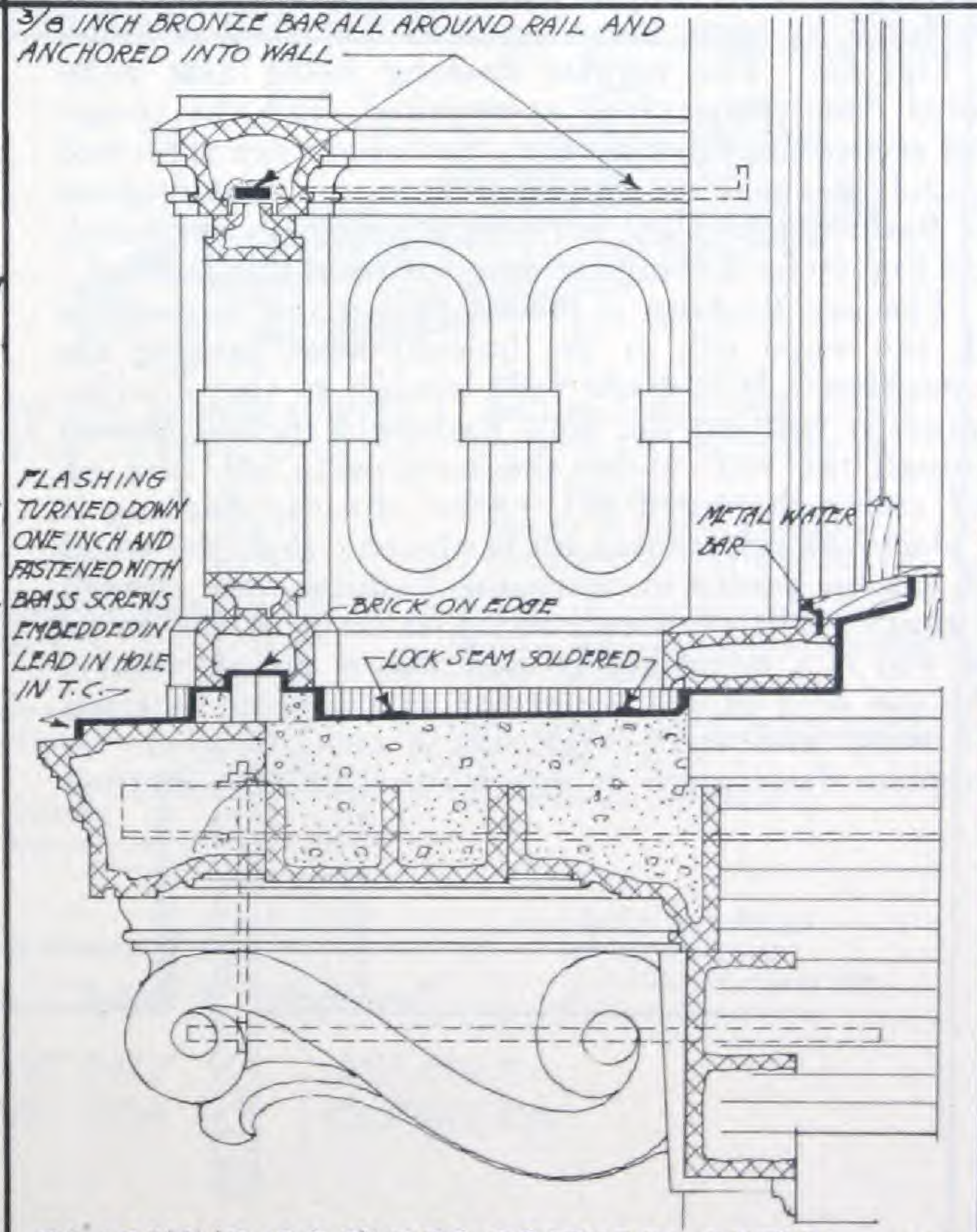
FLASHING FOR CORNICE WITH BALUSTRADE (59)



FLASHING FOR CORNICE WITH PARAPET (60)



FLASHING OF GUTTER OF TERRA COTTA CORNICE AND PARAPET (61)



FLASHING OF FLOOR OF TERRA COTTA BALCONY AND METHOD OF SECURING RAIL (62)

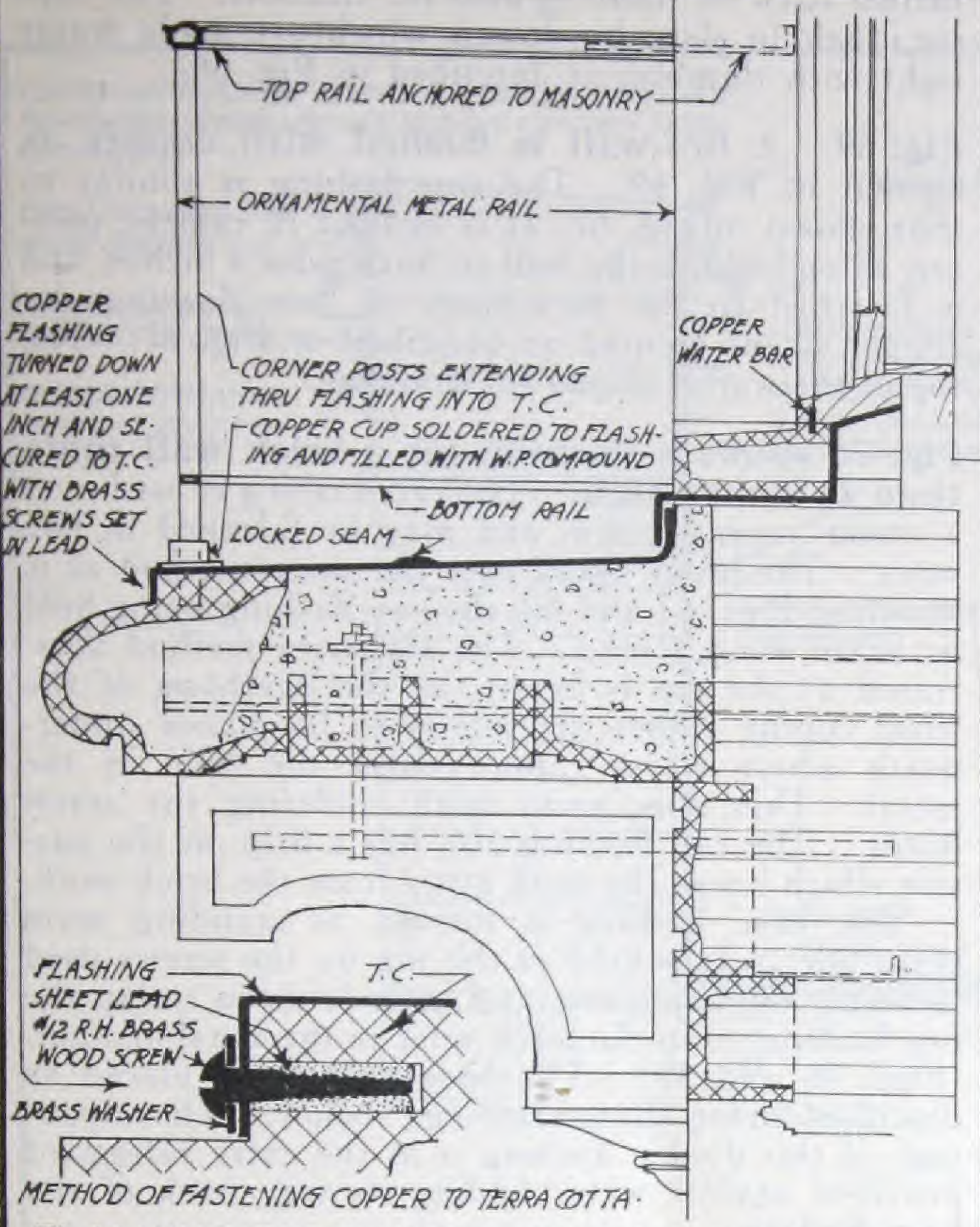
Fig. 63. A method of flashing a projecting terra-cotta balcony enclosed by a metal rail with a door or window opening to it is shown in Fig. 63. Particular attention is called to the method of fastening the outer edge of the copper work to the terra cotta as shown in detail in the lower left-hand corner. When designing the terra cotta, provision should be made for a step 1¼ inches or more in height above the top molding. When the terra cotta is cast, and while it is still in a plastic state, a row of holes is punched in the face of this step about ⅜ of an inch in diameter, 1½ inches deep, and 8 or 9 inches apart. Before the copper is placed there should be inserted into these holes cylinders of sheet lead of a length about ⅛ inch less than the depth of the hole and a diameter the same as that of the hole. The edge of the copper flashing containing a row of holes corresponding to the holes in the terra cotta is then turned down over the step at least 1 inch. A No. 12 round-head brass wood-screw is inserted through the copper and into the lead cylinder. As the screw is driven home it expands the lead cylinder, forcing it against the sides of the hole in the terra cotta, forming in effect an expansion bolt, and making a tight and secure fastening. It is generally not necessary to solder over the top of the screw-heads but if much water will come over the edge of the step it is good practice to solder. After being thus secured at the outer edge the copper is laid over the floor of the balcony, using soldered lock seams where necessary, and then turned up against the masonry at least 4 inches where it is lapped by the cap flashing. When the flashing is penetrated by upright posts such as the corner posts of the balcony rail, in this instance, the place where such penetration occurs must be carefully protected by some means such as described in detail in Fig. 66. The regular flashing being first completed, then penetrated as required, and the corner post secured to the masonry, the copper cap is formed around the post or slipped over it and soldered to the flashing and filled with waterproofing-compound. (See Fig. 66 for a complete description of this method.)

The cap flashing is placed before the terra-cotta sill, the wood sill, or the balcony-floor flashing are in position. It is made wide enough so that on completion it will lap the floor flashing 4 inches, extend through the wall under the terra-cotta sill, and up and under the wood sill. After the cap flashing is in place the terra-cotta sill is placed; then the wood sill. Some prefer to make the flashing wide enough so that it will even extend up in back of the wood sill, but if a water-bar is used this is not necessary. The use of a copper water-bar at the joint between the wood and terra-cotta sills is recommended. A complete description of this feature and the method of its application may be found in the drawing and description of Fig. 11.

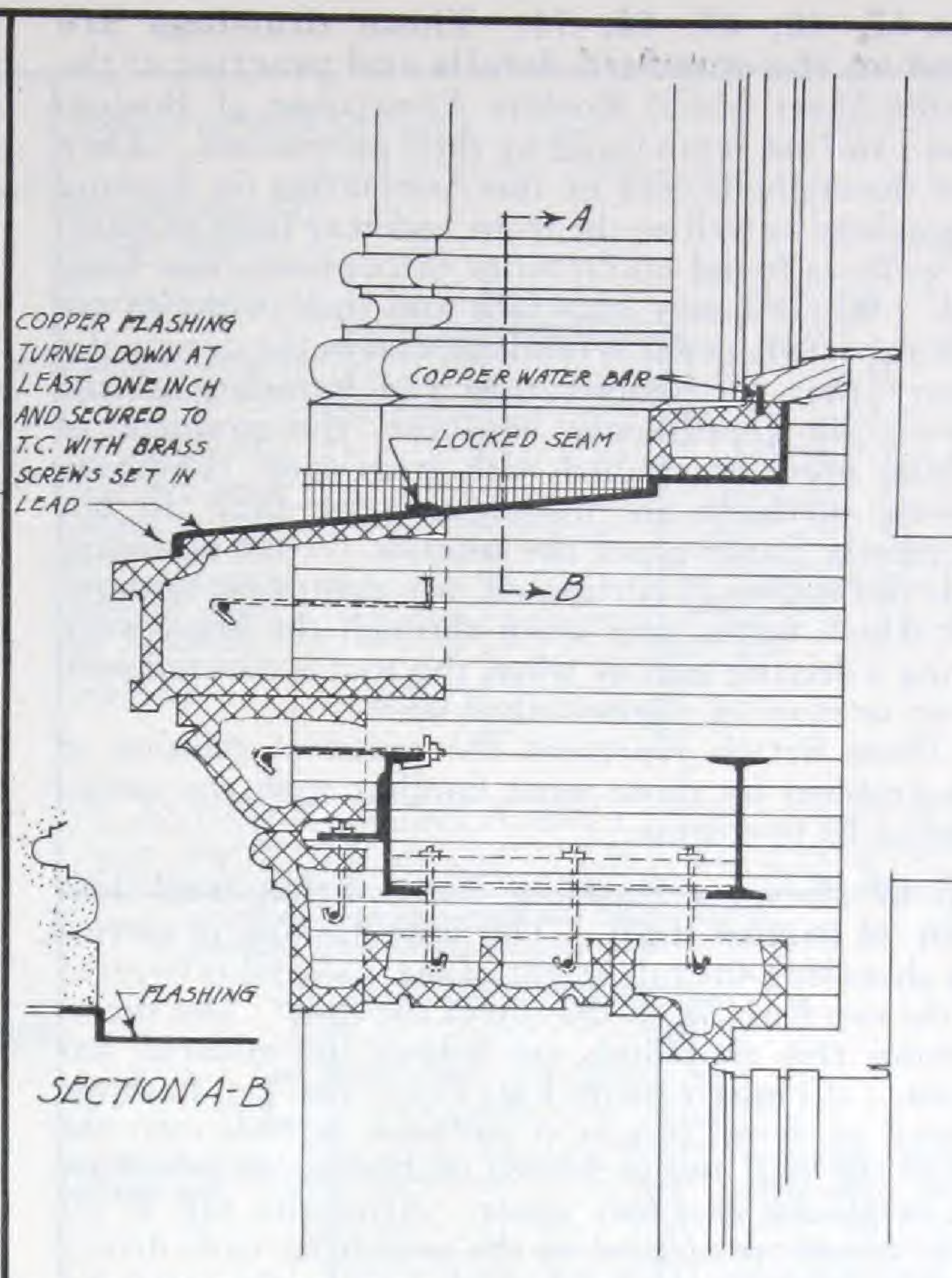
Fig. 64. When a terra-cotta balcony or similar projecting feature serves as the base for columns, pilasters, or other projections above the floor of the balcony, the flashing is applied as shown in Fig. 64. It is placed in a similar manner to that described for Fig. 63 except that the cap flashing placed under the terra-cotta window sill is also carried around under the column bases, into the joints of which it is set (as shown by the section in the lower left-hand corner), and built in as the masonry progresses, and before the base flashing and that of the balcony floor is in position. Afterwards the cap flashing is turned down over the base flashing at least 1 inch and the seam soldered.

Fig. 65. A projecting window-cap or cornice of terra cotta surmounted by a terra-cotta balustrade is flashed and the rail steadied and secured to the roof as shown in Fig. 65. Attention is called to the method of avoiding movement of the rail by bracing it from the roof with bronze rods. For this purpose a ⅜-inch bronze bar extending the length of the rail is placed on top of the balusters and connected by vertical rods to the steel framing below and also to a stay rod from the main roof. It is important that the points where the ends of these rods are fastened to the main roof be well-flashed. A complete description and a drawing of a suggested means of doing this is given in Fig. 28.

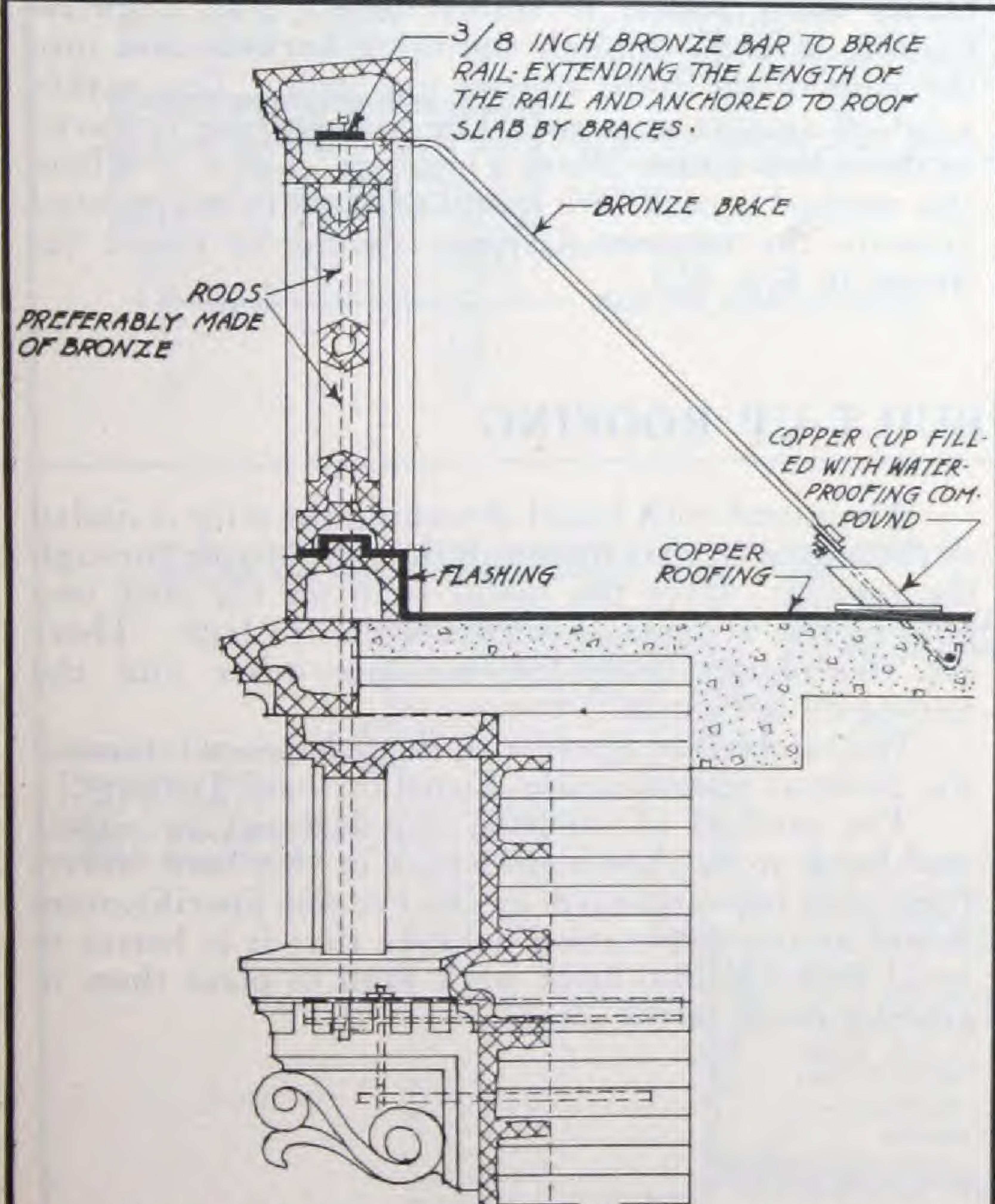
Fig. 66. The left-hand side of the lower part of Fig. 66 shows a half-section and the right-hand side shows a half-elevation of a method of forming a flashing cap of copper and securing it to the regular roof flashing at such places as it may be necessary to penetrate the roof flashing to permit the passage of rods, dowels, anchors or similar metal shapes. In the illustration the cap is shown round but it may be made of any shape, and it should conform roughly to the contour of the penetrating member. The regular flashing sheet is cut at the points of penetration and the surplus metal turned up against the rod. After the regular flashing is completed the cap is placed in position. The cap is made out of a flat piece of copper with the lower edge turned out. This piece is either bent around the rod and the ends lapped and soldered or the ends soldered first and slipped over the top of the rod. The lower edge (previously turned out) is then soldered to the flashing. Upon completion the cap is filled with a waterproofing-compound. The cap must be made large enough so the sides will clear the rods, etc., at least 1 inch. Two examples of the use of this cap are shown in Figs. 63 and 65.



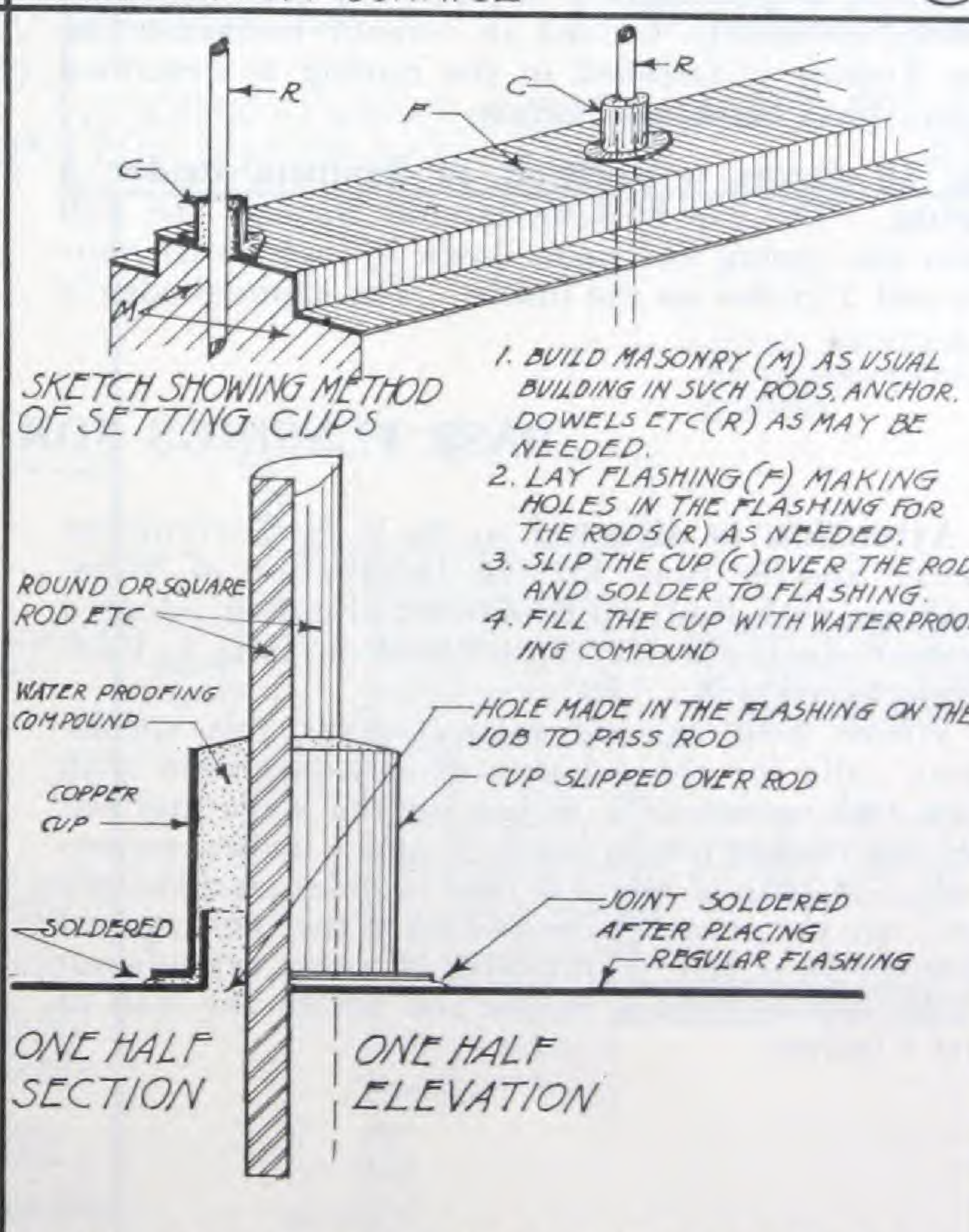
FLASHING FOR A METAL RAILING OVER A TERRA COTTA BALCONY (63)



FLASHING FOR COLUMN BASE OVER A TERRA COTTA CORNICE (64)



FLASHING AND BRACING OF TERRA COTTA BALUSTRADE ABOVE CORNICE (65)



COPPER CUP TO BE USED WHEN FLASHING OR ROOFING IS PIERCED BY RODS ETC (66)

Figs. 67, 68, 69, 70, 71. These drawings are based on the standard details and practice of the Master Sheet Metal Roofers Association of Boston, Mass., and are reproduced by their permission. They show the methods used by this Association for flashing the copings as well as the front and rear faces of parapet walls as found on factories throughout New England. Where heavy snowfalls and sudden thaws are to be expected, and it is fundamental in the design of a factory that the temperature and humidity of the interior be kept nearly constant, the problem of flashing must be studied with great care. Ordinary flashing methods are insufficient, for they do not completely damp-proof the interior. It is necessary to devise means of cutting off any dampness or moisture which might seep down through the brick work during a driving rain or when the roof is covered with a foot or more of water-soaked snow.

These details represent the practical solution of this problem by those most familiar with the conditions to be overcome.

Fig. 67 shows a flashing for a brick wall less than 24 inches high. The base flashing is carried as a sheathing the full height of the wall and is covered by the cap flashing on the top of the wall. The sheets forming this sheathing are joined by soldered flat seams. (Compare with Fig. 70). The cap flashing, formed as shown to give it stiffness, extends over the top of the wall and is riveted on both sides to copper straps placed two feet apart. After the cap is set these straps are secured on the outside by nails driven into the joints of the brick work, and on the inside by soldering to the sheathing. The top of the wall should be sloped slightly to drain inward. The cap flashing is usually bedded in cement mortar. The base flashing is fastened to the roofing as described under "Base Flashings" below.

Fig. 68 shows a method of flashing under a coping. The cap flashing extends through the wall under the coping and turns down ½ inch on the outside and 3 inches on the inside. The exposed edge is turned back on itself ½ inch for stiffness. The coping is held in place by dowels which are made water tight with thimbles as described in Fig. 66.

Fig. 69. A fire-wall is flashed with copper as shown in Fig. 69. The cap flashing is similar to that shown in Fig. 67. It is bedded in cement mortar, extends down the wall on both sides 4 inches, and is fastened to the sheathings or base flashings by copper straps secured as described in Fig. 67. The top of the wall is sloped for drainage.

Fig. 70 shows a flashing for a brick wall more than 24 inches high. The cap flashing is used over a wood coping piece, and may be fastened in two ways. The lower figure uses the same method as is shown in Figs. 67 and 69, the cap flashing being held by brass wood screws. The alternate method illustrated at the top is better, as the overhang of the wood coping allows the screws to be placed underneath where water cannot enter the hole in the metal. This does away with soldering the screw heads. The cap flashing also has a drip on the outside which keeps the wash away from the brick work.

The base flashing is formed as standing seam sheathing. It is held at the top by the screws used to fasten the cap piece, and extends down to lap the cap flashing set in the brick work in the usual manner. (Figs. 48 and 49). The base flashing is placed as described under "Base Flashings" below. The advantage of this double flashing is in the extra safeguard provided against water finding its way back of the base flashing.

Fig. 71. A flashing for a Brick parapet wall faced with stone is shown here. The counter-flashing extends through the brick backing and into the joint of the stone courses one inch. This makes a cut-off against seepage. The base flashing is placed as described under "Base Flashings" below. Where this method is used with a wall exposed to heavy wind pressure the counter flashings should be keyed (as shown in Fig. 62.).

BASE FLASINGS FOR BUILT-UP ROOFING

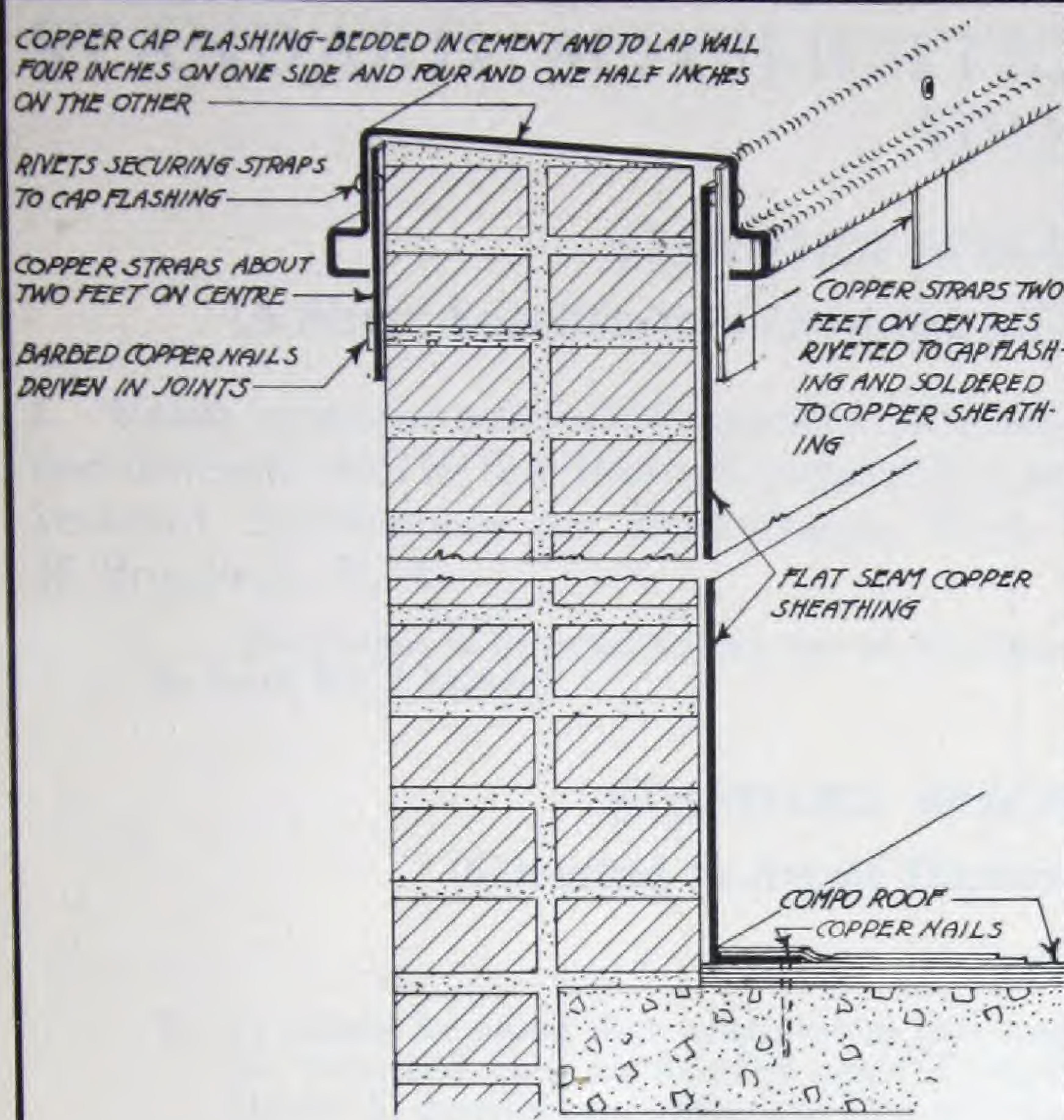
Attention is directed to the U. S. Government Master Specifications for the Installation of Metal Flashings with Built-up Bituminous Roofing, adopted by the Federal Specifications Board on June 1, 1924, as Specification No. 156.

Where used against vertical walls this specification calls for three layers of felt saturated with pitch and extending 6 inches up the walls and out over the roofing felt to lap 6, 5, and 4 inches, respectively. A strip of metal is then rounded, not sharply bent, into the proper shape and set in the angle against these layers of felt. This strip of metal extends out on the roof at least 6 inches and up on the wall at least 5 inches.

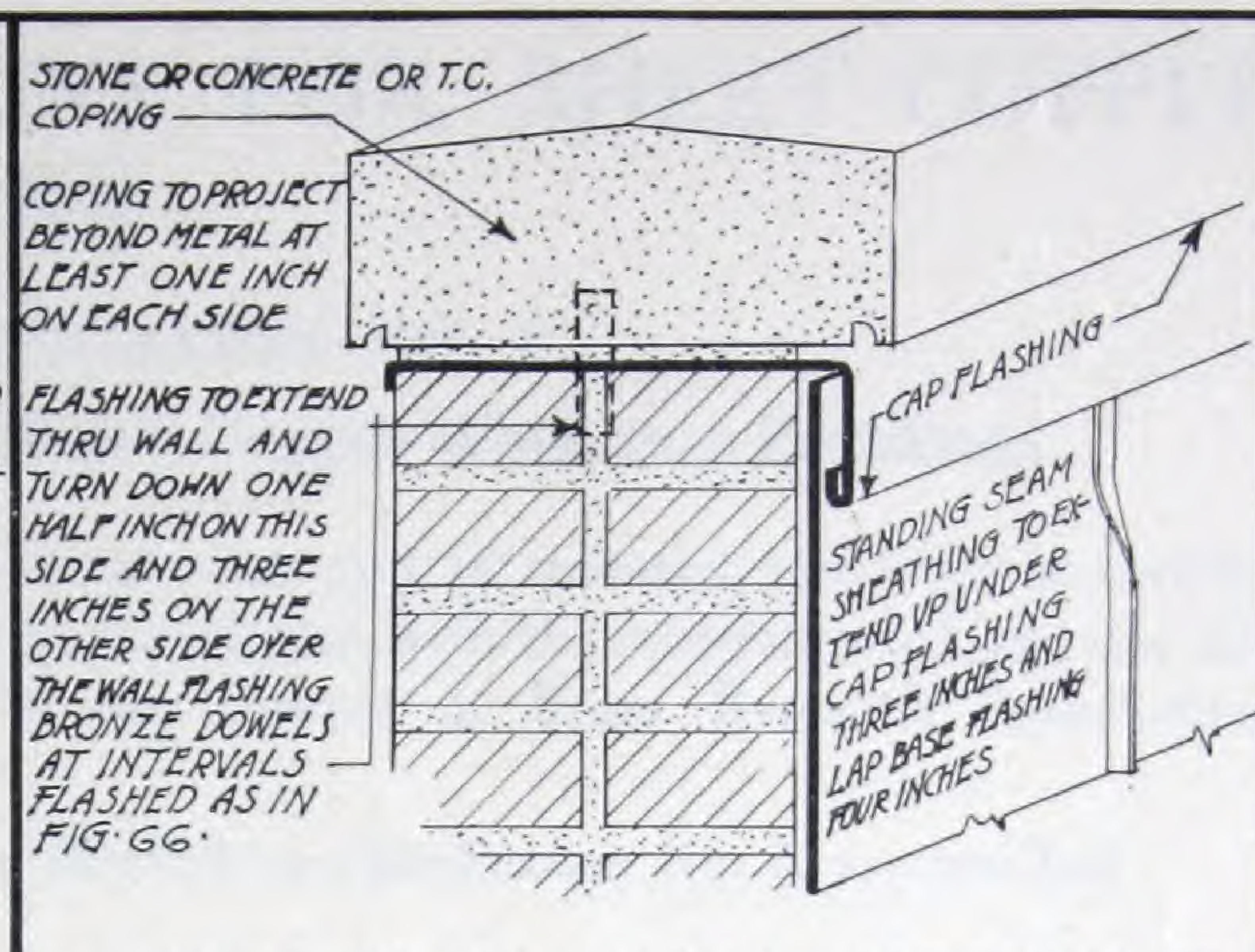
When used with board sheathing the strip is nailed at the edge every six inches to the roof boards through the roofing. Over the metal strip on the roof two plies of felt at least 15 inches wide are laid. These are thoroughly cemented to each other and the roofing by hot pitch.

The association agrees with the recommendations of the Federal Specifications Board for base flashings.

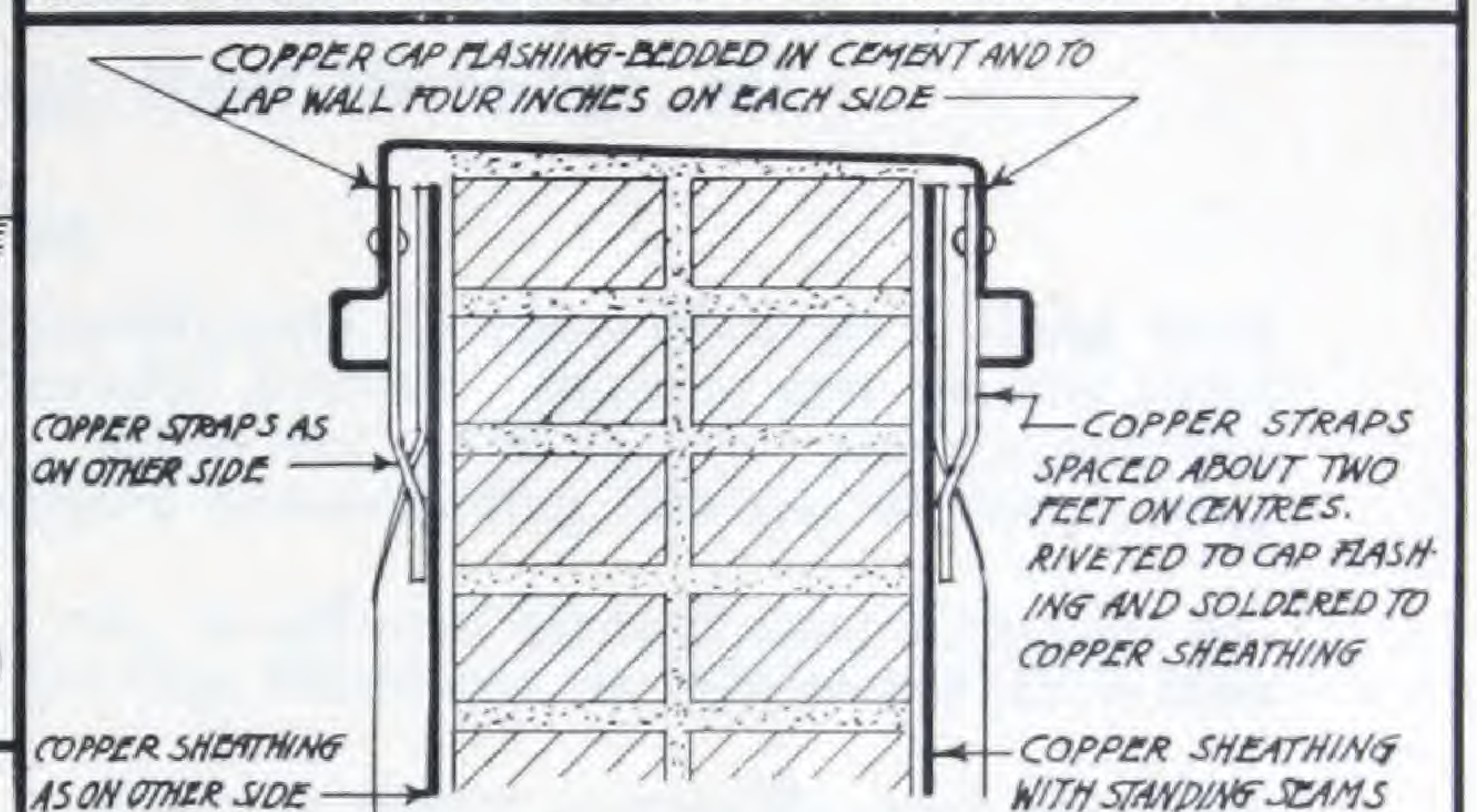
The method of securing cap-flashings in reglets and brick work shown elsewhere in this book differs from that recommended by the Federal Specifications Board as the Association believes that it is better to build flashings into brick work than to place them in grooves made in the joints.



FLASHING FOR A BRICK WALL LESS THAN TWENTY FOUR INCHES HIGH (67)

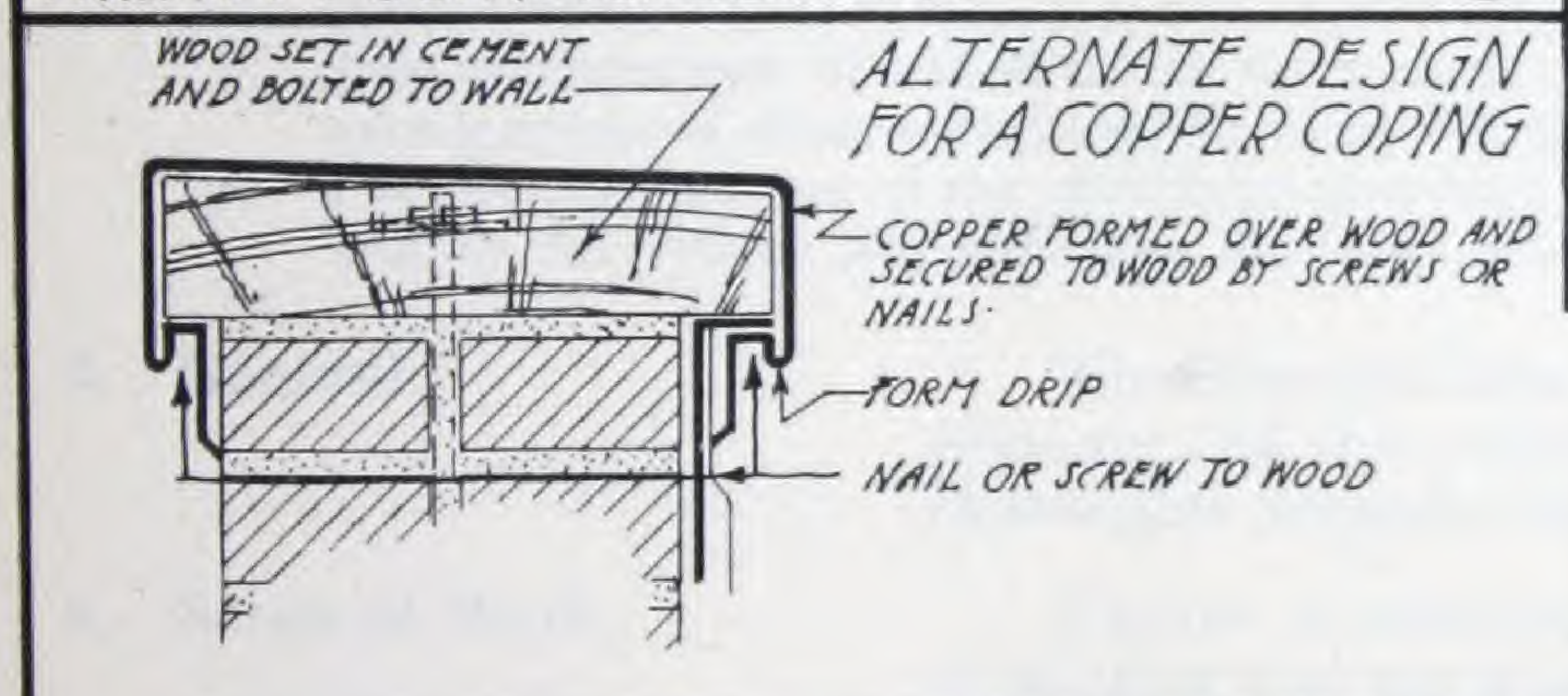


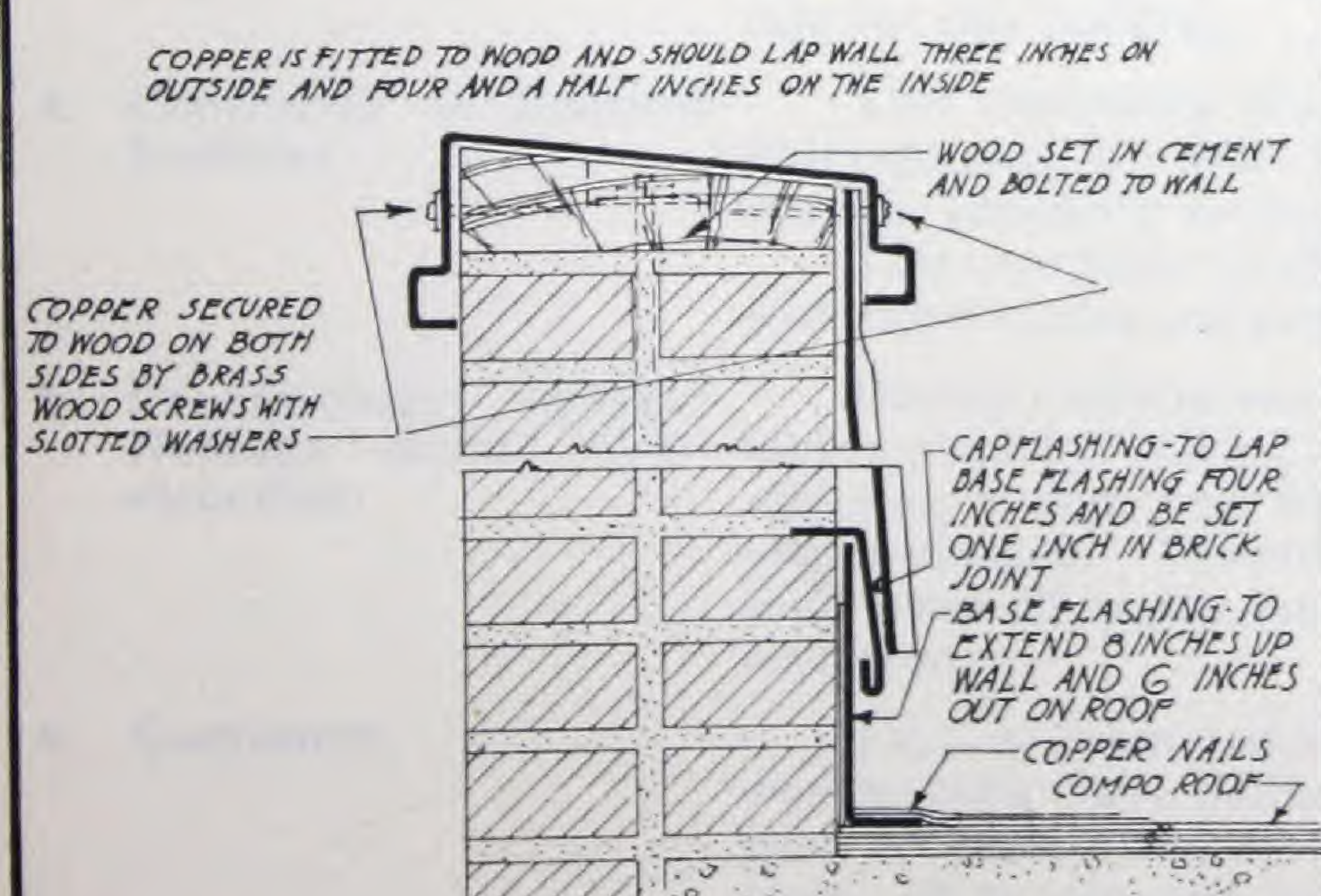
FLASHING FOR A BRICK WALL MORE THAN ONE FOOT HIGH ABOVE COUNTER-FLASHING (68)



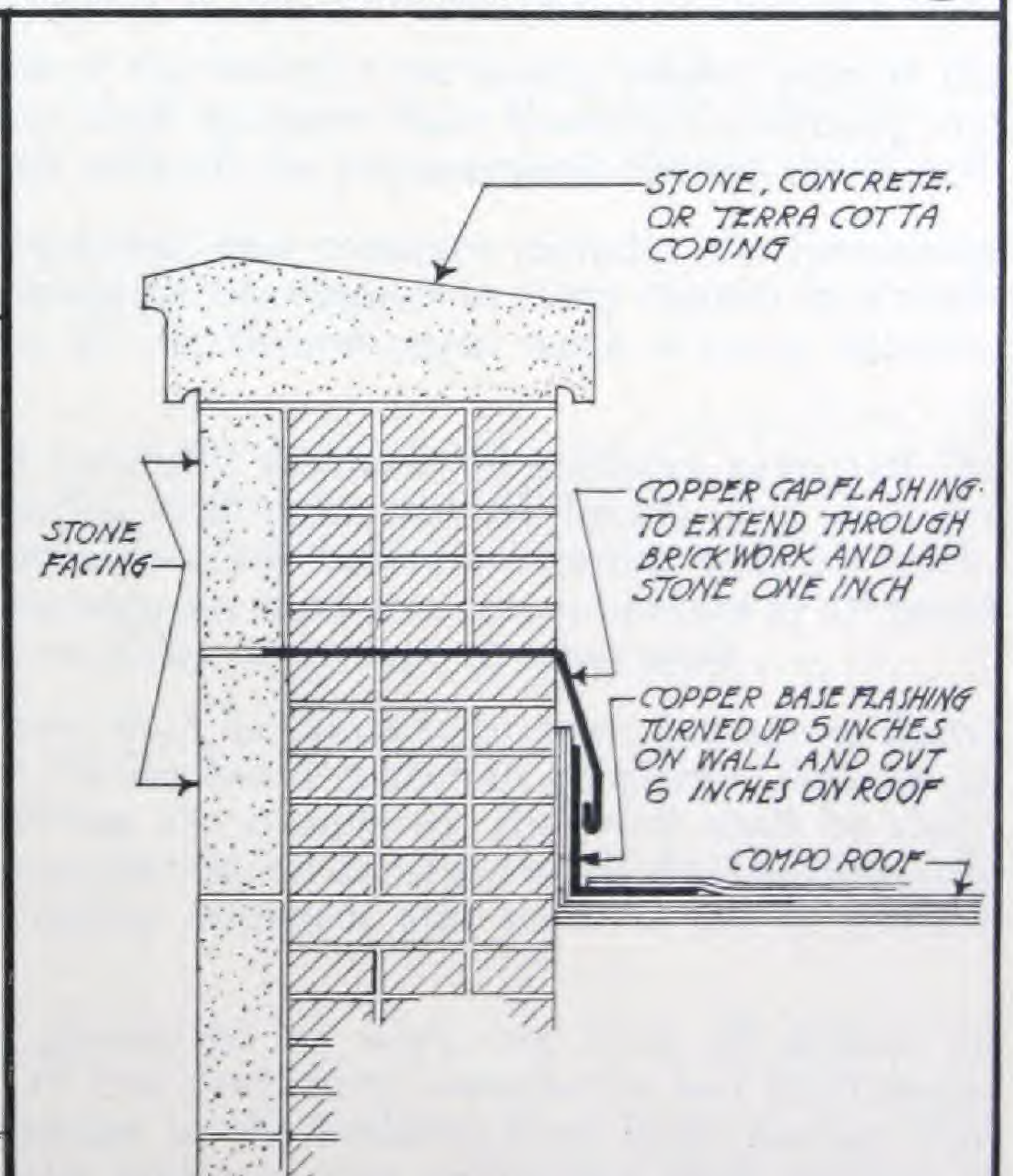
COPPER COPING AND FLASHING FOR THE TOP OF A BRICK WALL (69)

ALTERNATE DESIGN FOR A COPPER COPING





FLASHING FOR A BRICK WALL MORE THAN TWENTY FOUR INCHES HIGH (70)



FLASHING FOR A BRICK PARAPET WALL FACED WITH STONE (71)

STANDARD SPECIFICATIONS FOR SHEET-COPPER WORK

STANDARD SPECIFICATION NO. 1

(A Short Specification Covering all Sheet-Copper Work in a Building)

1. Unless otherwise particularly specified, all sheet-metal work and all material and labor in connection therewith shall be furnished and performed in strict compliance with the recommended practice and Standard Specifications for Sheet-Copper Work of the Copper & Brass Research Association, 25 Broadway, N. Y.

[Attention is directed to the use of Alternate Methods in Specification No. 2, as described in Note No. 1 below.]

STANDARD SPECIFICATION NO. 2

(Covering in detail Flashings, Roof-Drainage, etc.)

NOTES

1. It should be noted that, wherever in this long specification Alternate Methods of doing work are described, they are listed in order of recommended practice. In every case the first listed (letter A) describes recommended best practice. When this specification is used in connection with specification No. 1, there should be a definite understanding between the contracting parties about Alternate Methods.
2. Where Different Methods of applying flashings, etc., to different kinds of construction are collected under one general heading (as in No. 29—Cap Flashings) the paragraphs have been sub-numbered 1, 2, 3, etc.
3. The arrangement of subjects has been made to agree, as nearly as possible, with the usual arrangement of sheet-metal specifications for the average building.
4. For the convenience of the specification-writer paragraphs have been numbered consecutively, and all Alternates and Different Methods have been given a designating legend.

2. General. The General Conditions of the contract are hereby made a part of the contract and this contractor shall examine these General Conditions and thoroughly acquaint himself with all the requirements therein contained.

3. Scope of Work. Except as otherwise specified this contract includes the furnishing of all labor and materials necessary to complete in every respect in accordance with the best practice all the Sheet-Copper work of every description for this building.

4. Contractor to Examine Surfaces This contractor shall carefully examine all surfaces prepared for flashings, etc., by other trades, shall point out all defects, and shall see that the necessary corrections are made before proceeding with his work.

This contractor shall arrange his work so as to co-operate at all times with other trades and prevent delay or damage to other work.

5. Precautions against Damage during Construction. During construction care shall be taken to prevent damage to flashings in place by walking or placing heavy materials on them. As soon as soldering is done and flashings are completed, the work shall be thoroughly cleaned. Toward completion, all damaged work shall be repaired, shall have all stains and debris removed, and shall be left in perfect condition.

6. Guarantee. This contractor shall guarantee his work free from all defects of workmanship for a period of two years after completion and shall make good all defects and all damage to the building from leaks during that time. If so directed by the architect this contractor shall execute a proper guarantee bond.

7. Preparation of Surfaces. All surfaces to receive flashings shall be made smooth and even, and all nail heads shall be set.

8. Building Paper.

All surfaces to be covered with copper shall be covered first with rosin-sized or asbestos-felt paper weighing not less than 6 pounds per 100 square feet. Paper shall lap 2 inches and be nailed with flat-head copper nails.

9. Sheet-Copper.

Where shown on drawings or described in these specifications all sheet-metal of every description shall be of copper.

All copper sheets used shall be rolled from copper conforming to the Standard Specifications of the American Society for Testing Materials.

All copper sheets shall be plainly marked with the manufacturers' name and the weight.

10. Soft (Roofing Temper) Copper. Hard (Cornice Temper) Copper.

Except as otherwise specified, all copper throughout the work shall be of 16-ounce, soft (roofing temper) copper sheets.

All leaders, eaves troughs, and molded hanging gutters shall be of 16-ounce, hard (cornice temper) copper.

11. Tin.

All tin used for tinning seams for soldering, etc., shall be best grade, pure metal.

12. Solder.

All solder shall be of the best grade, equal to Specification B-32 of the American Society for Testing Materials, and shall be composed of one-half pig lead and one-half block tin (new metals).

13. Flux.

Rosin shall be used as a flux.

14. Nails and Fastenings.

All nails, rivets and similar fastenings used throughout the work shall be of best grade hard copper or brass.

Nails shall be wire nails not less than No. 12 gage and not less than $\frac{7}{8}$ inch long.

15. Tinning.

The edges of all sheets to be soldered shall be tinned $1\frac{1}{2}$ inches on both sides. Rosin shall be used as a flux.

16. Soldering-Coppers.

All soldering shall be done with heavy soldering-coppers of blunt design, properly tinned before use. They shall weigh not less than 6 pounds to the pair. For flat seam work on decks, in gutters, etc., they shall weigh not less than 10 pounds to the pair.

17. Soldering.

Soldering shall be done slowly with well-heated coppers so as to thoroughly heat the seam and completely amalgamate the tin with the solder. Plenty of solder shall be used and the seam shall show when finished at least one full inch of thick, evenly flowed solder.

18. Slopes of Roofs.

On roofs having a slope of less than 1 on 4 all flat and lap seams shall be soldered. On roofs having a slope of 1 on 4 or greater, flat and lap seams shall not be soldered.

19. Seams.

Standing Seams shall finish not less than 1 inch high.

Flat, or Lock, Seams shall finish not less than $\frac{1}{2}$ inch wide.

Lap Seams, where soldered, shall finish not less than 1 inch wide.

Lap Seams not soldered shall lap at least 3 inches.

All Flat and Lap Seams shall be made in the direction of the flow.

20. Double Lock Seams.

Sheets to be double or copper-locked shall have a $1\frac{1}{2}$-inch turn-up at the edges which shall be folded over with the edge of the adjoining sheet three complete turns so that the finished seam shall be 6-ply and shall finish $\frac{1}{2}$ inch wide. The seam so formed shall be malleted down and on flat surfaces the edge shall be tipped with solder.

21. Loose-Locked Seams. Where, on copper-covered surfaces, an intersection of roof planes, or an abrupt change of slope, shall occur, the joint between the flashings on the two surfaces shall be an unsoldered loose-locked seam similar to a standing seam hammered flat or a double lock seam. It shall be placed as close to the line of intersection as possible and shall be so formed as to preclude leakage. It shall not be fastened to the roof, except that at the cross seams of the sheets so joined cleats may be set close to the loose-locked seam.

22. Crimped Copper. All copper sheets used for flashings, gutter-linings, etc., shall be crimped by passing through heavy rolls to form 3/16-inch ridges in the sheets in the direction of the short dimension.

23. Size of Sheets. (–1.) Strip copper shall be used for all flashings up to 18 inches in width.

(–2.) In general flashings for flat surfaces such as decks, crickets, etc., shall be of sheets not larger than 18 x 24 inches. Under special conditions larger sheets may be used with the approval of the architect.

(–3.) All built-in and lined gutters shall be flashed with sheets of size specified under "Built-in Gutters."

24. Cleats and Fastenings. All flashings over 12 inches wide shall be fastened by cleats 1½ inches wide and about 3 inches long, spaced as specified elsewhere. They shall be secured to the roof by two nails set about ¾ of an inch from the end and shall have the end turned back ½ inch over the nail heads. The free end of the cleat shall be turned over ½-inch to engage the edge of the sheet and shall be locked into the seam. Where seams are soldered cleats shall be tinned. Except as otherwise specified cleats shall be spaced not more than 12 inches apart. Where used with 18 x 24-inch sheets four cleats shall be used for each sheet.

Flashings less than 12 inches wide shall be secured by nails spaced as specified for different types of flashings. Where flashings are nailed the nailing shall be restricted to one edge only. Nails shall be near the edge and shall be evenly spaced not more than 4 inches apart, unless otherwise specified.

25. Exposed Edges. The exposed edges of all flashings shall be folded under ½ inch, in such manner as to conceal them from view.

26. Flashings — Where Required. All intersections of roofs with vertical surfaces of every kind and all openings in roof surfaces, shall be flashed with copper. The method of flashing, except as otherwise shown or specified, shall be base and counter-, or cap, flashing.

27. Continuous Flashings. Where the design or construction is such that the base and counter-flashing method is impracticable, flashings shall be made continuous from the roof surface up and into the vertical surface. Flashings of this type shall be made generally in two or more pieces, locked and soldered together. Where possible the joints shall be made by flat or double lock seams. Otherwise lap seams shall be used.

28. Base Flashings. (–1.) Unless otherwise specified or shown on the drawings base flashings shall be, in general, at least 4 inches high, and shall project at least 4 inches out on to the roof. Flashings shall be full pieces 96 inches in length. On sloping roofs they shall lap longitudinally at least 3 inches. On flat roofs the joints shall be flat-locked and soldered.

(–2.) Against stucco-coated walls, the metal lath shall lap outside the flashing so that the stucco shall finish over the flashing.

29. Cap Flashings or Counter-Flashings.

Cap flashings shall turn down over base flashings not less than 4 inches. They shall be secured to vertical surfaces as follows:

(–1.) Wood Work. They shall extend up under exterior coverings such as shingles, slate, etc., at least 2 inches above the butt of the second course, and in no case less than 4 inches above the roof, and shall be nailed along the top edge about every 8 inches.

(–2.) Mason Work. They shall extend into joints of masonry walls 4 inches and have the inner edge turned back on itself ½ inch. The sheets shall be bent to the required shapes, and built in with the mason work. No cutting-out of joints for setting flashings will be allowed.

(–3.) Reglets. They shall be secured, as specified below, in reglets cut in the masonry.

(–4.) Stucco on Wood. When used with stucco-covered wood-frame walls, cap flashings shall be formed over a ⅞-inch base board and extend up the wall at least 2 inches above the base board, and be nailed at the top edge with nails about 8 inches apart. Metal lath shall be placed over the flashing and the stucco shall be finished against the base board.

(–5.) Stucco on Masonry. They shall be built into the masonry as the work progresses and shall project out from the wall as required and turn down over the base flashing. The stucco shall finish against the cap flashing.

(–6.) Concrete Walls. They shall be set in the forms before the concrete is poured. They shall extend into the wall at least 2 inches and shall have the inner edges turned back ½ inch.

30. Flashings. (Masons' Specification.)

Where indicated on the plans or specified build in all flashings furnished by the sheet-metal contractor and as directed by him.

31. Step Flashings.

Step flashings shall be used where vertical surfaces occur in connection with slopes.

(–1.) They shall be formed of separate pieces built into the masonry as specified for cap flashings in masonry. Steps shall lap generally 3 inches, but in no case less than 2 inches, and shall not be soldered.

(–A.) Lap joints shall be vertical.

(–B.) Lap joints shall be normal to the slope of the roof.

(–2.) They shall extend into the wall one course of brick and turn up 1 inch in back. Each piece shall be formed to lap the next piece below 1 inch on the sides, and as each piece is set both the horizontal and vertical joints shall be soldered to the piece below so that the finished flashing shall form a complete watertight cap.

32. Vent Flashings.

All pipes passing through roofs shall be flashed and counter-flashed. Base flashings shall extend out on the roof not less than 6 inches.

(–1.) They shall be of sufficient length to cover the roofing course next below the pipe and to extend up under the roofing course above as far as possible without puncture by nails.

(–2.) Where vent-pipes extend more than 12 inches above the roof the counter-flashing shall be caulked into the hubs or held with brass clamps embedded in elastic cement or white lead. It shall lap the base flashing at least 4 inches.

(–3.) Where the vent extends not more than 12 inches above the roof surface, it shall be flashed as follows:

Cast-iron Pipe. The base flashing shall be carried up to within an inch of the top of the pipe and shall be counterflashed by a copper cap 6 inches high, turned over and down into the pipe at least 2 inches.

Threaded Pipe. The base flashing shall extend up to within 2 inches of the end of the pipe, which shall be threaded. After the flashing is in place the threads shall be covered with white lead and an iron or steel cap, of such design as to enclose the flashing material, shall be screwed onto the pipe.

(–4.) Patented vent-flashing devices may be used, subject to the approval of the architect. They shall be made of 18-ounce copper, shall be the product of a recognized manufacturer, and shall be installed according to manufacturer's directions.

33. Open Valley Flashings. (–1.) Open valleys shall be not less than 4 inches wide. The proper width shall be determined by the following rule: Starting at the top with a width of 4 inches, increase the width 1 inch for every 8 feet of length of the valley. Flashing pieces shall be full length sheets, and of sufficient width to cover the open portion of the valley and extend up under the roof covering not less than 4 inches on each side.

There shall be no longitudinal seams in open valley flashings. The cross seams at the ends of sheets shall be locked and soldered. Edges shall be turned back ½ inch and held in place by cleats spaced not more than 12 inches apart, and nailed to the sheathing with two nails.

(–2.) "Fold-over" Flashings shall be used, of such design as to allow not less than 3 inches beyond the fold to be covered by the roofing. They shall be secured by cleats not more than 12 inches apart.

(–3.) Where two valleys of unequal size come together, or where the areas drained by the valley are unequal, there shall be placed in the valley a "crimp," angle, or Tee not less than 1 inch high. This may be formed in the valley sheet before placing, or it may be made of a separate piece soldered to the valley sheet.

34. Closed Valley Flashings. (–1.) Built-In Method. Flashing pieces for closed valleys shall be of sufficient length to extend 2 inches above the top of the roofing piece and lap the flashing piece below 3 inches, and of width sufficient to extend up the sides of the valley far enough to make the valley 4 inches deep. They shall be placed with the roofing so that all pieces are separated by a course of shingles or slate. Pieces shall be set so as to lap at least 3 inches and to be entirely concealed by the roof covering. They shall be fastened by nails at the top edge only.

(–2.) Large Piece Method. Before the roof covering is laid this contractor shall place in all valleys long strips of copper of sufficient width to make a trough at least 4 inches deep. These strips shall be laid from bottom to top of the valley with a 4-inch lap, unsoldered. Where such strips are not over 12 inches wide they shall be fastened with nails spaced every 18 inches along the outer edge. Strips over 12 inches wide shall be fastened by 1½-inch cleats, spaced every 30 inches.

(–3.) All closed valley flashings shall be made with a "crimp" or ridge down the center equal to the full thickness of the roof-covering courses.

35. Cricket or Saddle Flashings. Crickets or saddles formed back of all vertical surfaces, such as chimneys, etc., breaking through sloping roofs, shall be covered with copper. The flashing of these crickets shall be made a part of the flashing along the sides of the chimney, etc.

36. Window and Door Head Flashings. Window and door frames set in frame construction shall have a flashing of copper over the head. This flashing shall be set after the frame is placed and shall be carried up the wall 2 inches above the butt of the second course of shingles, slate, etc., and in no case less than 3 inches above the window head. The bottom edge of the flashing shall be

(–A.) secured to the trim by an edge-strip as specified elsewhere.

(–B.) turned down over the trim and shall finish back of, and be secured by, the outside molding of the trim.

(–C.) nailed at 1-inch intervals to the vertical face of the trim.

(–D.) bent at a sharp angle to bear tightly against the top fillet of the molding, and the upper edge of the flashing, under the shingles, shall be secured by nails placed about 8 inches apart.

37. Window and Door Sill Flashings.

(–1.) Sill flashings for window frames in frame construction shall be set before the frame is placed. They shall extend to the back of the window sill and shall be nailed after the frame is set, and shall also extend 4 inches outside beyond the sill.

(–2.) Wood sills set in stone or concrete shall have a strip of 20-ounce or heavier hard (cornice temper) copper at the joint. Just before setting the wood sill this reglet shall be filled with waterproofing-compound and the strip shall be embedded in it.

38. Window and Door Sill Flashings. (Carpenter's Specification.)

The sills of wood frames set in stone or concrete shall have a slot 1 *inch deep to receive a copper flashing strip.*

39. Window and Door Sill Flashings. (Mason's Specification.)

Stone or concrete sills under wood window or door frames shall have a 1-*inch by* 1-*inch reglet cut or cast in them to receive a copper flashing strip.*

40. Water-table Flashings.

Water-table flashings shall extend up the sheathing at least 2 inches above the butt of the second course of siding, and in no case less than 4 inches.

(–A.) It shall be formed over the edge of the water-table to make a drip and shall be secured at the upper edge by nails 4 inches apart.

(–B.) If the edge-strip method of fastening is used the upper edge shall be nailed about every 8 inches.

41. Hips and Ridge Flashings.

(–1.) Install hip and ridge flashings over battens set by other contractors. They shall be secured on either side of the roll by round-head brass wood-screws about 12 inches apart, set through washers. Holes in the roof covering shall be drilled. The heads of the screws and washers shall be soldered.

(–2.) Hip and ridge rolls of design shown shall be installed over battens, etc., set by other contractors. The apron shall be held down by 3/16 x 1-inch brass bands 30 inches apart, secured to the batten by brass wood screws through countersunk holes.

42. Column-Cap Flashings.

The upper surfaces of all exposed column caps shall be flashed. The flashing shall be formed to fit the cap and shall be turned down ½ inch over the edge of the cap and nailed every 1½ inches. A separate piece shall be fitted over the dowel and soldered to the main flashing.

43. Column-Base Flashings.

Bases of wood columns shall be flashed by a cap made to fit the dowel used to secure the column. The cap shall have a flange extending out on the roof on all sides the necessary distance to provide for waterproofing, as specified elsewhere for different kinds of roofing materials.

44. Ventilator Flashings.

Where metal ventilators are used on a roof they shall be connected to the flashing by a soldered lap seam. The flashing sheet shall extend out over the roofing on all sides at least 6 inches.

(–1.) On shingle or slate roofs the flashing shall be secured by round-head brass wood-screws set through holes drilled in the roof covering. The screws shall be set with slotted brass washers and shall be soldered to the flashing. The sides of the flashing shall be formed with a mallet over the roofing.

45. Guy-Anchor Flashings.

When bolts or similar devices penetrate sloping roof coverings, they shall be flashed as follows:

Before the courses above the bolt are laid, a piece of copper about 8 inches wide shall be placed over the lower roof covering and the sheathing with the bolt projecting through a hole in the center. The sheet shall be of sufficient length to lap the first course below the bolts 4 inches and up and under the courses above as far as possible without puncture by nails. The joint between the bolt and the sheet shall be closed by

(–A.) Soldering to the sheet a flanged copper thimble placed around the bolt and caulked with waterproofing-compound.

(–B.) Soldering the sheet to the bolt.

46. Flashings for Built-Up Roofing. (Roofers' Specification.)

When used with built-up roofing base flashings shall be not less than 5 inches high and extend at least 6 inches out on the roof, in accordance with Specification No. 156 *of the Federal Specification Board for the Installation of Metal Flashings with Bituminous Built-up Roofings.*

Cap flashings shall be installed by the Sheet-Metal Contractor as specified elsewhere. The Roofing Contractor shall read carefully the sheet-metal specification.

47. Gravel-Stops.

Gravel-stops shall be placed at the edges of all built-up roofs covered with slag or gravel. They shall be formed of one piece of copper to provide a ridge the full height of the roofing material at the outer edge. They shall project on the roof at least 4 inches and be nailed on top of the waterproofing fabric, embedded in pitch, and covered with two layers of felt well-mopped with pitch.

48. Flashing Around Steel Struts.

Where steel struts, etc., penetrate a flat roof, a copper pan about 2 inches high above the finished roof level shall be formed around the member. It shall have a flange projecting out on top of the roofing felt or waterproofing at least 2 inches. This flange shall be covered with two layers of felt carried out on the roofing not less than 6 inches and well-mopped with pitch. The pan so formed shall be filled with pitch, and the top surface sloped to drain freely.

49. Flag Pole Flashings.

(–A.) Flag poles penetrating a flat roof shall have a circular base flashing extending up the pole at least 10 inches, and 1 inch larger in diameter than the pole. A conical hood secured to the pole by a 1-inch brass band set in white lead and bolted, shall lap the base flashing at least 3 inches. The whole flashing shall be so constructed as to allow for the movement of the pole.

(–B.) Patented flashing-flanges or similar devices for flashing flag poles shall be used subject to the approval of the architect. They shall be the product of a recognized manufacturer and shall have a flashing of 18-ounce copper. They shall be installed in accordance with the manufacturer's directions.

50. Flashings for Clay and Cement Roof Tile.

Flashings shall be laid as specified elsewhere for base, cap, and continuous flashings. All base flashings running with the length of the tile shall extend out on the roof under the tile as far as is possible without puncture by nails, and shall be formed into a trough by turning up the edge at an angle of 90 degrees. So far as is possible flashings shall be laid to avoid sharp bends and angles, and shall not be nailed. They shall be held in place by the weight of the tile. The manufacturer's specifications shall be followed for flashings of special shapes, etc.

Where vent-pipes occur the tiles broken by the pipes shall be bedded in mortar or secured with nails and covered with the flashing. Flashings shall extend down the roof to the end of the tile, out on the sides to the first lock or trough, and up the roof to and over the wood battens or to the nails securing the tiles.

Valley flashings shall be formed to fit the type of tile used and shall extend up the sides of the intersecting slopes, or be turned over the supporting wood battens, to form a valley at least 4 inches deep.

Flashings against the sides of dormers, etc., on sloping roofs shall continue as a trough under the tile and discharge out on top of the tile below or into the gutter.

Exposed flashings shall extend with the length of the tiles at least 6 inches and shall be formed over them. Those extending crosswise shall terminate in depressions or locks and be held in place by the adjoining tiles.

51. Scuttles.

Covers of roof scuttles shall be covered with copper. Sheets shall be laid with flat seams soldered, and shall be carried over the edge to the underside where they shall be secured with nails 1½ inches apart.

52. Curbs.

Curbs around roof openings shall have a flashing turned down on the inside about 3 inches and secured with nails 1½ inches apart. It shall extend out on the roof as specified for base flashings.

53. Edge-Strips.

Where indicated on the drawings, flashings shall be secured by brass edge-strips, ⅛ inch thick by 1¼ inches wide. Strips shall be fastened to the vertical face of the projection by brass screws about 12 inches apart, and set to allow the copper flashing to be hooked over the lower edge at least ⅜ of an inch.

54. Drips.

Where indicated on the drawings, form drips of 24-ounce hard (cornice temper) copper strips. These shall be nailed to the projection and bent down. They shall project not more than ⅜ of an inch below the sheathing or the upper fillet of the molding, and shall have the flashing hooked over the lower edge at least ⅜ of an inch.

55. Eaves-Strips.

Install strips of copper along all eaves and roof edges except where gutters occur. They shall have a ½-inch folded lower edge projecting ⅜ of an inch below the sheathing or fillet of the molding to form a drip, and shall extend back on the roof 3 inches. At the intersection of vertical roof surfaces they shall have a folded rib of height equal to the thickness of roofing. They shall be installed in not exceeding 96-inch lengths, with 2-inch end laps, shall be laid underneath the sheathing paper and nailed along the inside edge.

56. Eaves Trough and Hangers.

Eaves trough, or half-round hanging gutters, of the size and type shown, shall be installed where shown on the drawings. They shall be in 10-foot lengths and shall be joined by a 1-inch lapped and soldered joint, or by slip joints. All joints shall be made in the direction of the flow.

Eaves trough shall be provided with end pieces, end caps, outlet tubes and mitres as required.

Eaves trough shall be supported by **(1)** copper or brass strap or rod hangers of approved design; **(2)** heavy copper wire hangers; or **(3)** cast brass hook-type hangers.

(–1.) Strap and rod hangers shall be spaced not more than 36 inches apart and shall be secured to the roofing by brass screws.

(–2.) Wire hangers shall be spaced not more than 24 inches apart and shall be secured to the roofing by heavy copper nails.

(–3.) Cast brass hangers shall be adjustable for slope and shall be spaced not more than 36 inches apart. They shall be secured by brass screws.

57. Molded Gutters.

Molded gutters of the size and design shown shall be installed where indicated on the drawings. They shall have a flange which shall extend up on the roof sheathing as far as possible without puncture by nails, and shall be held in place by cleats 30 inches apart.

If impracticable to provide the flange, the gutter edge shall be locked and soldered to a flashing strip set as above specified.

The outer edge of the gutter shall be stiffened by a brass rod or rectangular bar, and provided with a proper drip. Braces of heavy copper or brass, spaced 30 inches, shall be locked around or riveted to the outer edge, and secured to the roof sheathing above the flange or flashing by 2 brass screws.

Joints of molded gutters shall lap 1 inch and be secured with rivets spaced 1 inch, and soldered.

Outlets shall be provided with tubes soldered to the gutter of proper length to connect to the leaders.

58. Linings for Molded Gutters.

Where indicated on the drawings install gutter-linings of soft (roofing temper) copper. They shall be shaped to fit the bottom of the gutter and shall slope toward the outlet. All joints shall be lapped and soldered.

59. Pole Gutters and Gutter-Strips.

Where indicated on the drawings form gutters over wood poles or strips set by the carpenter contractor. Linings shall extend up the roof as far as is possible without puncture by nails, and shall be secured with cleats spaced 24 inches. Linings shall turn down over the pole and lock to a flashing strip, secured to the outer face of the pole by cleats and extending out over the roof covering at least 4 inches.

Outlets shall be provided with tubes soldered to the lining and of length sufficient to connect to the leaders.

60. "Shingle Flashings."

All outlets of molded or pole gutters set on sloping roofs covered with shingles, slate, etc., shall be provided with a "shingle flashing," and a tube of length sufficient to connect to the leader.

This flashing shall consist of a sheet extending down the roof from the outside of the gutter at least one course of shingles and at least 6 inches up the roof under the gutter. It shall extend 6 inches on either side of the outlet. A sleeve shall be soldered to it and shall be inserted into the leader. The tube shall be set into this sleeve, which shall project down the leader beyond the end of the tube.

The flashing shall be constructed to prevent leakage under the gutter and down the outside of the tube through the hole in the roof sheathing

61. Wire Strainers.

(–A.) All gutter outlets shall be fitted with approved copper wire strainers of the basket-type set in loose.

(–B.) All gutter outlets shall be fitted with No. 14 gage copper wire strainers of the basket-type set in loose.

Vertical wires shall be spaced ½ inch, and shall be reinforced with horizontal wires 3 inches apart, extending around the basket, with each joint soldered.

62. Leaders, Conductors, or Downspouts.

Leaders shall be installed where shown on the drawings, of the shapes and sizes indicated. They shall be held in position, clear of the wall, by

(–1.) Brass hooks, driven into the wall not more than 6 feet apart.

(–2.) Heavy brass or copper straps, ⅛ by 1½ inches, spaced not more than 6 feet apart, soldered to the leaders, and fastened **(1)** to wood work by brass screws; **(2)** to masonry by brass screws set in lead sleeves.

(–3.) Ornamental straps of **(1)** stock design; **(2)** the design shown, and made of **(1)** hard (cornice temper); **(2)** soft (roofing temper) copper.

Leaders shall be in 10-foot lengths, and shall be lapped, tinned inside and out, and soldered. A 1½-inch slip joint shall be provided every 20 feet of leader.

When leaders connect with underground drains they shall be fitted into drain-pipes and shall have the joint neatly cemented. All leaders not so connected shall have elbows at the bottom. Those discharging at ground level shall have heavy shoes with reinforced ends.

63. Leader Heads.

Leader heads of **(1)** stock design; **(2)** the design shown, shall be placed where indicated on the drawings. Outlet tubes from gutters shall extend into them about 2 inches. The bottom of the leader head shall be soldered to the leader.

Large leader heads (12 inches wide or over) shall have a heavy copper-wire removable screening over the top.

64. Reglets.

Where indicated on the drawings or where directed by the architect flashings shall finish in reglets in the masonry cut by others where located by this contractor.

The flashing shall be turned into the reglet the full depth and shall be turned back to form a hook.

(Continued on next page)

(§ 64 continued)

After the flashing is in place the reglet shall be filled and caulked, using molten lead on flat surfaces, and lead wool on vertical surfaces.

After caulking the reglet shall be made smooth by filling with elastic cement.

65. Reglets. (Masons' Specification.)

Where indicated on the drawings or where directed by the architect cut reglets in the masonry as located by sheet-metal contractor for the insertion of flashings.

Reglets shall be not less than 1 inch wide and 1 inch deep. They shall be cut with true and straight edges, with sides and bottom roughened.

66. Scuppers.

Flash all scuppers with copper, making same a part of the roof flashing. Scupper flashings shall cover the interior completely and shall extend through and project outside of the wall. Seams shall be locked, or lapped, and soldered. Scupper flashings shall be joined to roof flashings by soldered seams.

67. Scuppers. (Carpenters' or Masons' Specification.)

All enclosed roof surfaces, including balconies, etc., shall be provided with scuppers. The bottom shall be not more than 2 inches above the finished roof surface at the lowest point.

68. Built-in Gutter-Linings.

Where indicated on the drawings line all box or built-in gutters with copper. Gutter-linings shall fit loosely and shall have the back edge 3 inches higher than the front edge. Back edges of linings shall lock to copper roof covering and when used with slate, tile or shingles shall extend up the roof as far as possible without being punctured by the nailing of the roof covering, and shall be secured with cleats.

(–A.) Small sheets shall be laid with seams staggered. All seams shall be flat locked and soldered. Sheets shall be secured by cleats.

(–B.) Large sheets used to form gutter-linings shall be laid the long way of the gutter. The ends of the sheets shall be locked to cross strips about 4 inches wide by flat or double-locked seams fastened by cleats.

Great care shall be exercised to avoid any sharp bends or creases in the linings at the sides, and to this end sheets formed in the shop for linings shall not be bent more than 90 degrees. In so far as is possible all linings shall be formed on the job from flat sheets.

All gutter-linings over 24 inches wide shall have a longitudinal seam running the length of the gutter of flat or double-locked type, soldered and secured by cleats.

Linings shall be connected to flashings or to copper roofing by means of large loose-locked seams, folded flat and so placed as to avoid any possibility of leakage. In general the connection shall be made as close to the intersection of the roof slope and the inside of the gutter as is possible.

The back edge of all gutter-linings finishing against vertical walls shall be carried 4 inches above the outside edge of the cornice and shall be covered by cap flashings built into the wall.

(–1.) Gutter-linings in WOOD CORNICES shall have the front edges turned under the lower edge of an ⅛ by 1¼-inch brass strip screwed to the vertical face of the top member of the cornice. This strip shall be so placed as to form a proper drip.

(–2.) Gutter-linings set in STONE CORNICES shall be placed over a wood sheathing forming the slope of the gutter. The outer edge shall be secured in a reglet. Where the wash slope slopes out, and where the width of the outer sheet of the lining exceeds 20 inches, a standing seam shall be formed as close as is possible to the reglet to prevent discoloration by the wash from the gutter and to provide for expansion.

(–3.) Gutter-linings in CONCRETE or BRICK WORK shall be secured to batten or nailing strips set by other contractors according to directions by this contractor.

(–4.) Gutter-linings formed back of COPPER CORNICES shall have the front edge locked to the top edge of the cornice over a ⅛ by 1¼-inch brass strip.

69. Built-in Gutters. (Carpenters' Specification.)

(–1.) *Form gutters as shown on the plans, and as directed by the architect, of 7/8-inch boards with nail heads set and all surfaces smooth. Consult with the sheet-metal contractor on all details in connection with his work.*

(–2.) *Set wood blocking and 7/8-inch sheathing in masonry gutters as shown on the plans and directed by the architect to form backing for lining sloped to outlets. Make all surfaces smooth with nail heads set. Consult with the sheet-metal contractor on all details in connection with his work.*

70. Built-in Gutters. (Masons' Specification.)

Cut all reglets for gutter-linings as shown on plans or directed by the architect. Set all batten and nailing strips in masonry necessary for the sheet-metal work.

Form all depressions in masonry for outlet boxes as shown on the plans.

Form slopes to outlets in gutters and back of projections which are flashed.

All concrete surfaces to be covered with flashing shall be washed smooth with neat cement. Where cinders have been used in the concrete it shall be painted with two heavy coatings of asphalt paint.

Consult with the sheet-metal contractor on all details in connection with his work.

71. Outlets for Built-in Gutters.

Outlets shall be formed as shown on the drawings. The gutter lining shall be turned into them and secured by soldered lap seams.

Holes shall be cut as soon as the lining is placed and temporary spouts shall be put in until the permanent drainage is ready.

Outlets shall be connected to leaders by

(–A.) a 20-ounce copper tube;

(–B.) a 4-pound lead gooseneck.

Connections shall be flanged at the top and soldered to the outlet-box lining; the bottom shall have soldered to it a brass ferrule or caulking ring furnished by the plumbing contractor.

72. Cast Strainers.

All outlets from gutters and roofs shall be provided with heavy, cast brass, removable strainers the full size of the outlet-box.

73. Roof Drains.

(–A.) Approved types of patented roof drains may be used. They shall be furnished and set by the plumbing contractor and connection shall be made to them by the sheet-metal contractor in strict accordance with the manufacturer's directions.

(–B.) Roof drains shall consist of a circular or square pan whose diameter or side shall measure at least 4 inches greater than the outlet, and have a depression of not less than 1½ inches.

They shall have a flashing extending out on roof surfaces, on all sides of the pan, not less than 6 inches. The flashing or pan shall be provided with a rib forming a gravel-stop or of proper height to receive **(1)** built up **(2)** promenade-tile roofing.

(–C.) Roof drains shall consist of a copper flange extending out on the roof on all sides a distance at least equal to the size of the outlet. The flange shall be provided with a rib or gravel-stop against which to finish **(1)** built up **(2)** promenade-tile roofing.

Outlets from drains shall consist of

(–A.) a 20-ounce copper tube, soldered to the **(A)** pan; **(B)** flange, and **(1)** extending into the drain pipe at least 6 inches with the outside coated with asphaltum; **(2)** with a brass ferrule or caulking ring soldered to the end for connection to the drain pipe by the plumbing contractor.

(–B.) a 4-pound lead gooseneck, flanged at the top and soldered to the **(A)** pan; **(B)** flange. Connections to the drain pipe shall be made by the plumbing contractor.

74. Roof Drains and Gutter Outlets. (Plumber's Specification.)

(–1.) *Furnish the sheet-metal contractor all brass ferrules necessary for connecting the drainage system and the roof drains and outlets shown on the plans, and connect copper tubes fitted with these ferrules to the drain pipes by caulked and leaded joints.*

(–2.) *Furnish and install complete with all piping connections the patent drains shown on the plans. Make provision, where necessary, for the work of other trades in connecting to the drains.*

(*Continued on next page*)

(§ 74 *continued*)

(–3.) *Where shown on the plans furnish and install 4-pound lead goosenecks of a length necessary for the sheet-metal contractor to make a proper connection to the outlet-box or roof drain, and with a brass ferrule or caulking ring for connecting to the drain pipe.*

75. Expansion Joints.

(–1.) Roofs. Where an expansion joint in the roof slab is shown on the drawings, this shall be flashed with a strip of 16-ounce copper bent around a piece of No. 14 band iron about 6 inches wide heavily coated with asphaltum. The flashing shall be set while the waterproofing is being laid and shall be built into it. When the roof covering is placed all the space around the flashing shall be filled with mastic or other waterproofing-compound. The contractor may submit for approval other methods of flashing expansion joints.

(–2.) Gutters. Where called for on the drawings provide sliding expansion joints, the full height of the gutters. The lining of the gutters shall be turned up and folded back to form flanges over which a cap shall be placed to form a water-tight joint. There shall be sufficient play between the cap and the flanges to allow for the full movement of the gutter and the building. The cap shall have soldered on its outer edge a V-shaped curb to turn water from the roof into the gutter.

76. Flashings for Stone Cornices.

All stone cornices, band-courses projecting more than 12 inches, balconies, balustrades, etc., shall be flashed. Flashings shall be secured on the outer edge by reglets. The back edge shall be continuous at least 3 inches above the outer edge and in no case less than 4 inches high. Where stone facing on brick backing is used, cap flashings shall be set in and shall cover the base flashings.

Where stone balustrades occur on top of a cornice, etc., flashings shall be set in reglets under the balusters, or shall be continuous through the balustrade and either turn down over the interior roof base flashings as a cap flashing, or be connected thereto by a loose-locked joint. Dowels for fastening balustrade members together shall penetrate the flashing and shall be covered with a copper cap or thimble soldered to the flashing.

Flashings over 24 inches wide shall have a full-length longitudinal seam secured by cleats, and shall have a standing seam as close to the outside reglet as possible.

77. Flashings for Terra Cotta.

Where indicated on the drawings terra cotta shall be flashed to make a water-tight job. The top surfaces of all projections such as the washes of cornices, where the wash is formed of more than one piece, shall be completely flashed, and where so shown on the drawings all single deck projections shall be so flashed.

Flashings shall be secured to the outer edge of terra-cotta projections by forming around a rolled nosing or bull-nose formed in the terra cotta, or by brass screws set with lead sleeves into holes formed in the terra cotta. The screws shall be set through washers and shall be soldered to the sheet. The sheet so secured shall extend down below the edge of the terra cotta not more than $\frac{3}{8}$ of an inch to form a drip.

Cornices, band cornices, gutters, etc., formed in terra cotta, or masonry faced with terra cotta, shall have a continuous flashing running from the outside edge up to and behind the cap flashings.

Cap flashings shall be built in behind the terra-cotta facing above all cornices, etc. They shall extend up the wall at least one course of terra cotta and shall lap the cornice flashing 4 inches. Where the design does not permit a 4 inch lap of base and cap flashings the lap shall be soldered.

Balconies with balustrades shall have continuous flashings running from under the door or window sills through the balustrades and to the outside edge of the projection. Flashings shall be formed with flat-locked or lapped seams well-soldered.

All flashings over 24 inches wide shall have a full-length longitudinal flat or double-locked seam secured by cleats.

Around column bases, etc., flashings shall be turned up and into a reglet formed in the terra cotta, or into the first joint of the terra-cotta facing in such a manner as to make a water-stop.

Where rods, etc., necessary to support terra-cotta balustrades or other architectural members, penetrate the flashings, the joint shall be made water-tight as follows: The rods being in place, the flashing pieces shall be marked, punctured and set in position by sliding down over the rods; or, if this method is impracticable, the sheets may be slit to allow them to be slid into place. The slit shall be made tight by soldering a strip over it. Cups or thimbles, conforming roughly to shape of the rod or bar shall be then placed over the rods and soldered to the sheet. They shall be at least 1 inch larger all around than the rods. The cups shall then be filled with mortar or an approved waterproofing-compound.

78. Terra Cotta. (Manufacturers' Specification.)

(–A.) *Edges of all top pieces of projections to be flashed shall have formed on the vertical face holes about* 9 *inches apart,* ⅜ *inch in diameter, and at least* ¾ *inch deep, for fastening the flashings.*

(–B.) *All edges to receive flashings shall have a rounded nosing around which the flashing sheet may be hooked and held firmly.*

Where indicated on the drawings or directed by the architect, holes shall be formed in the terra cotta for securing flashing cleats. They shall be spaced about 12 *inches.*

79. Flashings Between Old and New Work.

Where new work is to be flashed against old work, such as at the junction between an old and new building, the flashing shall be such as to allow for settlement.

(–1.) Where the new wall is higher, the top of the old wall shall be covered with a flashing cap, extending completely over it and placed before the new wall is brought up. The old work shall then be flashed and counter-flashed to the new, the base flashing being turned down over the old wall and locked to the cap, and the counter-flashing being built in with the new work as specified elsewhere.

(–2.) Where the new wall is lower than an old wall, a flashing cap shall be placed over the new wall and turned down on both sides. The joint shall then be flashed and counter-flashed, the base flashing extending down over new wall and locking to the cap. The counter-flashing shall be set in a reglet cut for it in the old wall and caulked with lead wool.

(–3.) When the walls are level, the flashing shall consist of a cap continuous over both walls, properly sloped to shed water, and secured by brass wood-screws to the underside of a two-piece wood blocking secured on top of the walls by others. The flashing shall be in two pieces joined by a standing seam, or a loose-locked seam placed on one vertical side of the blocking so as to prevent leakage and to allow for settlement.

80. Skylights.

Where shown on the drawings build skylights of size indicated and of approved designed and manufacture, with curbs at least 10 inches above the roof. All sheet metal shall be 16-ounce hard (cornice temper) copper reinforced for strength and stiffness with steel sections. Copper and steel shall be insulated by strips of 3-pound lead or by an asbestos covering on the steel. All sash bars and bearings for glass shall have condensation gutters leading to the outside of the skylight. All skylights shall be made water- and weather-tight with joints interlocked, riveted and soldered and shall conform to the requirements of the National Board of Fire Underwriters. Duplicate sets of detail drawings shall be submitted for approval.

81. Louvres.

Where shown on the drawings louvres shall be formed of

(–A.) copper,

(–B.) wood covered with copper.

Duplicate sets of detail drawings shall be submitted for approval.

82. Cornices.

Where shown on the drawings cornices shall be erected of 20-ounce hard (cornice temper) copper. They shall be made in strict accordance with the profiles shown on drawings with moldings true, sharp and straight. All flat surfaces over 5 inches wide shall be crimped, all mitres

and joints carefully fitted, angles and corners reinforced, and all joints neatly riveted and soldered together and made water-tight. Cornice work shall be reinforced with properly-shaped steel brackets, separated from the copper by 3-pound sheet lead.

The top edge shall be formed over a heavy brass or bronze edge-strip or drip properly shaped to permit the joining of the top flashing or gutter-lining as specified elsewhere.

Ornaments shall be stamped in soft (roofing temper) copper with dies made from approved models.

Duplicate sets of detail drawings shall be submitted for approval.

83. Snow-Guards. (Roofers' Specification.)

(–1.) *Furnish and erect on sloping roofs approved copper wire snow-guards spaced not more than* 18 *inches apart in both directions and staggered.*

(–2.) *Furnish and set at eaves a snow-stop consisting of three ½-inch bronze bars set in approved manner with bronze supports.*

84. Ice-Box Drain-Pan.

Form ice-box drain-pan 2 inches deep of 20-ounce hard (cornice temper) copper with lap seams. The sides shall be stiffened by a roll at the top. The pan shall be not less than 16 inches square and shall have an 1½-inch outlet. The outlet shall have a tube soldered to the pan of sufficient length for connection to the waste line by the plumber.

85. Saw-Tooth Roofs.

Flashings for gutters in saw-tooth roof construction shall be carried up the sloping roof at least one foot beyond the "line of minimum-shadow," and shall be secured under the roof covering by cleats. Flashings shall be laid with flat seams, except on the vertical side where the flashings may be made with standing seams. Gutter-linings shall be made continuous with and an integral part of window sill and side flashings.

Gutter-linings over 18 inches wide shall have a full length longitudinal flat double-locked seam in the center of the gutter.

(*Under carpenters' specification provide for snow racks of boards to prevent injury when gutters are cleared of snow.*)

86. Cleaning Copper.

Except as otherwise specified all copper to be colored or painted shall first be thoroughly cleaned by scrubbing with a strong solution of caustic soda in hot water. After this solution has been applied the copper shall be washed off with clean water.

87. Coloring Copper.

(–1.) **Green Patina.** After the copper has been scrubbed clean the following solution shall be applied: (1) One pound of powdered sal ammoniac to 5 gallons of water. Dissolve thoroughly and let stand 24 hours. Apply with a brush, covering every part. Let stand one day and then sprinkle with clean water; or, (2), one-half pound of salt to 2 gallons of water. Apply as for (1) above.

(–2.) **Brown or Bronze.** Clean the copper of all foreign substances and debris and rub it thoroughly with waste soaked in boiled linseed oil until the desired color is obtained. Touch up solder with copper bronze.

88. Painting Copper.

All copper work to be painted shall first be scrubbed clean as specified elsewhere and coated with a wash composed of copper sulphate, 4 ounces to ½ gallon of lukewarm water, and ⅛ ounce of commercial nitric acid. This wash shall be applied with a brush, allowed to dry. The copper shall then be dusted with a dry brush, and given one coat of red-lead-and-oil paint and two coats white-lead-and-oil paint, composed of 15 pounds of red lead to 1 gallon of raw linseed oil, with not more than ½ pint of oil drier. All subsequent coats shall be composed of 15 pounds of white lead to 1 gallon of raw linseeed oil with not more than 5 per cent. of oil drier and the necessary color to give the desired tint. All painting materials shall be of the quality hereinafter specified under "Painting and Varnishing." Only those surfaces of copper work that will be exposed after installation shall be painted.

PART TWO

Notes on Copper Flashing Practice

KEEPING BUILDINGS DRY

An Article on the Flashing of Terra Cotta

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There is no doubt that in the past the importance of flashing in building construction has not been fully recognized. It has long been the custom to flash gutters and to use flashing at the junction of roofs and parapets, but it is only recently that designers and owners of buildings have begun to realize the necessity for flashing the entire upper and rear surfaces of exposed architectural features. It is now becoming evident that more attention must be paid to the protection of parapets and copings, the top of cornices and the floors of balconies.

An extensive examination of buildings erected in the last thirty years shows conclusively that the saturation of cornices and parapets is a very prevalent condition. In some cases the water enters at the mortar joints in the top of the coping. In other cases rain beats in and soaks in at the joints in the back of the parapet wall. Very frequently the mortar joints in the wash of the cornice are so cracked and porous that a lot of the water that runs down the parapet or falls on the top of the cornice finds its way into the interior of the wall.

Many architects and owners find that they have been placing too much reliance on the mortar joints. Having procured weatherproof building materials, such as terra cotta or hard stone, and having specified mortar of tested ingredients and approved mixture, they supposed that their buildings would be water-tight when erected. They are now finding that a great many buildings are not water-tight and on searching for the cause, they usually discover that the water is getting in at the mortar joints in the wash of the cornice and parapet coping.

At a first glance, it might appear that by carefully caulking or grouting the joints in the wash of cornices, parapets and balconies, it should not be very difficult to make them water-tight, but the present condition of a great many of these features proves that for one reason or another, water-tight joints are not being obtained. The bad condition of the mortar joints may be attributed to a variety of reasons, as for instance, poor workmanship, poor mortar, disintegration by frost, or cracking of joints due to thermal expansion and uneven settlement.

Many kinds of elastic cement and various caulking compounds for the protection of mortar joints are on the market and some of them remain impervious and somewhat elastic for several years but none of them appears to retain its original qualities indefinitely. Protection by means of caulking compounds involves periodical examination and considerable maintenance.

The results of poor joints are far reaching. The most common visible damage due to leaky joints in washes is unsightly staining and streaking on the face of the architecture. This staining and streaking is often extensive enough to destroy the beauty of a costly building. Frequently the streaks and discolorations clearly indicate that soluble portions of the mortar are seeping out at the beds and joints and are being deposited on the face of the building. Such a condition as this if allowed to continue will rapidly bring about the disintegration of portions of buildings on which it occurs.

Another serious result of leakage at joints is damage to plaster ceilings and walls within the building. Cases have been known where water entering at leaky joints in the washes of cornices and parapets has penetrated the walls to the depth of several stories below, causing considerable damage to the paint and plaster on the inside of the walls.

A still more serious condition, worse because it is out of sight, is the effect of dampness on steel framework within cornices, balconies and balustrades. The presence of moisture leads to rapid corrosion of the steel members and may eventually render projecting features unsafe.

Architects and owners of buildings have also to consider the damage that is caused by the freezing of water that collects in pockets and open spaces in the interior of walls and structural features. The expansion of ice repeated through a number of winters may finally rupture the masonry.

As impervious joints are difficult to obtain and expensive to maintain and as neglected leaks result in damage to valuable buildings it is advisable to cover wash surfaces with an impervious and permanent covering. Sheet copper is believed to be the most suitable material for this purpose.

Flashings should be carried entirely over the top of cornices and in most cases should be turned down over the nib far enough to form a drip and allow the water that runs down the wash to fall clear of the moldings. In this way the face of cornices may be kept clean and free from stains of any kind. When the top of a cornice is flashed, it is advisable to carry the flashing entirely through the base of the parapet and connect it with the cap flashing at the back of the wall. In this way water which enters at the top of the parapet is prevented from getting down behind the flashing at the back of the wall and is also prevented from getting underneath the flashing on the top of the cornice. The backs of parapets should be flashed whenever possible and the flashing should be carried over the top of the wall, laying it in the bed joint immediately below the coping. Then, if there is any leakage at the joints in the wash of the coping, the water cannot get behind the flashing, as it often does when the flashing is applied only to the back of the wall.

The unsightly discoloration that is so much in evidence on the underside of balconies indicates the necessity for better protection of these features. It is almost impossible to make the deck of a balcony water-tight by means of a cement or tile finish. A covering of sheet metal should be used in all cases. In flashing the tops of balcony slabs with sheet metal it is necessary to run the flashing out to the nib if the best results are to be obtained. Quite frequently the floor of a balcony is properly flashed, but the flashing terminates in reglets in the base of the balustrade. This practice almost invariably results in the saturation of the balcony slab by water which finds its way in at the joints in the balustrade and runs down behind and underneath the flashing. By carrying the flashing underneath the base course, any water that enters at the joints of the balustrade cannot penetrate to the balcony slab, and the soffit of the balcony is kept dry and unstained.

The washes of pediments and dormers should be completely flashed if staining and other evils of saturation are to be avoided.

While the use of sheet metal for the protection of mortar joints in washes may entail some slight additional expense at the time of the erection of the building, it will be found more economical in the end because the cost of maintenance will be avoided. Moreover, a building that is properly protected at the beginning will retain its original beauty and value.

FLASHINGS FOR TERRA COTTA

In general all built-in flashings should be furnished by the sheet-metal contractor and should be placed by the mason setting the terra cotta. All built-in sheets should be shaped by the sheet-metal man to conform to the measurements furnished by the mason, and sufficient metal left to allow proper connection to the adjoining flashing. In effect these built-in flashings, in the majority of cases, are counter-flashings.

The best method of fastening flashings to the blocks is that shown in Figure 63. Holes for plugs about ⅜ of an inch in diameter are formed in the terra cotta 8 or 9 inches apart. A small piece of sheet lead is rolled around a large nail, thus forming a hollow cylinder. This cylinder is inserted in the hole and a brass screw is turned through the copper into it. The lead fills the hole completely and makes a firm anchor for the screw.

Wooden plugs are not suitable, for in driving them into the holes there is danger of splitting the terra cotta and dampness is liable to cause them to swell.

It will be noted from a study of the drawings, (Figures 59 to 66), that there is one principle that enters into the erection of terra cotta; that is, to make as complete a cut off as possible so that moisture driving in through open joints, etc., cannot work its way into the interior of the building. This idea should be borne in mind in designing terra cotta construction and in providing proper flashings.

Flashings for terra cotta should be as nearly as possible continuous and should be so placed as to provide a complete waterproofing of the interior.

Balconies, balustrades, rails, copings, etc., require keying to hold them in place. This key or dowel is shown in Figures 59, 61, 62, and 65. It is not easy to get the flashing material over this if it is made exactly to dimension as drawn. As it is quite necessary that the copper be well fitted so that the superimposed pieces shall have a good bearing, it is suggested that the key be made slightly rounded and be shaped with mortar to fit the flashing strip as much as possible.

While it is general practice to make the fastenings of terra cotta of iron and steel, the use of brass and bronze for bars and anchors, and of copper wire is increasing. After the erection of terra cotta these members are concealed, inspection is impossible, joints open up, and dampness enters and rusts iron and steel fastenings. For the best work the hangers of all suspended terra cotta should be of non-ferrous metal, preferably bronze. While this adds somewhat to the cost of first installation, it insures a permanent job, requiring no

further attention, because the elements will not rust the bronze and damage the work.

Attention is called to the following paragraphs from the Standard Specification for the Manufacture, Furnishing and Setting of Terra Cotta, published by the National Terra Cotta Society, September, 1923.

PREPARATION FOR FLASHING

14.—*Where so shown the washes of all projecting cornices and other exposed horizontal surfaces shall have provision made for flashing. All surfaces where the wash pitches inward toward the structure and stops against superimposed work; all balcony floors, and all gutter grades shall have provision made for flashing.*

15.—*Raggles shall be provided to receive gutter linings and flashings when the joints can not be used for the purpose. Raggles shall be not less than ¾ inches deep.*

SUGGESTIONS FOR COROLLARY CLAUSES

87.—*In the case of parapet walls specifications should state that flashing if used shall be carried through the wall, or if flashing be not used the back of the parapet wall shall be damp-proofed and the water-proofing carried through the wall.*

88-2.—*In the specifications for sheet metal work there should be included a clause similar in purport to the following:*

"The washes on all cornices and other exposed surfaces, where shown or specified, shall be covered with (   ) which shall be turned up against vertical surfaces (cap flashed) and cemented into the raggles provided for the purpose in the Terra Cotta."

FLASHINGS FOR STONE WORK

One of the chief considerations in using copper with building stone is the avoidance of stains. When copper is applied directly to light-colored building stone or marble, sweating or condensation on the underside sometimes causes discoloration. To avoid this black waterproof paper (not tar felt) should be laid underneath the copper, so as to prevent direct contact between metal and stone.

It is also important to design the work so that the wash from the metal does not flow down over the face of the stone work. This, indeed, applies to any type of roof, for the dirt which collects on the roof will make any such wash objectionable.

This can be overcome by detailing the stone work to drain inward except the small portion beyond the outside reglet.

Good practice in stone work, with parapet and other walls faced with stone, calls for reglets rather than for step flashings in the joints. The reglet is cut straight or at an angle across the stone as the occasion may demand.

Many experienced stone setters consider lead wedges and lime mortar the best method of filling the reglet. The objection to this is the necessity for frequent repointing. Lead wool or molten lead do away with this objection.

Reference to Figs. 53 to 58 and to "Caulking," page 54, will make these points clear.

FLASHINGS FOR CLAY AND CONCRETE ROOF TILE

Roof tile are made of terra cotta and of concrete in a variety of designs. Terra-cotta tile has been in use for centuries. Recently concrete roof tile similar to terra-cotta tile has been put on the market with marked success. It is low in cost, easy to apply and of pleasing appearance.

Tile roofs require special treatment at the flashing points. Although the principles involved are fundamentally the same as other roofing materials, because of the shape and design of the tile, flashings for them must be of a special nature. Flashings are generally made of larger sheets than with ordinary roofing. This is because of the necessity of covering the joints near the flashing points and also conforming to the irregularity of the construction.

The use of 18-ounce copper is recommended for roof tile flashing. Its thickness helps materially in keeping it in position over the tile by giving it stiffness.

The principal considerations for flashings for roof tile are:

1. To use sufficient copper to cover the joints at the flashing points.
2. To apply the copper loosely and in such a manner that the heavy tile will not hold it too tightly or cut it.
3. To do as little fastening as is possible. The sheets are held in place by the weight of the tile.

These points are clearly shown in the drawings, Figs. 47 to 52.

COPPER OVER CONCRETE

When copper is used over concrete the surface should be made smooth by a wash of neat cement. Elastic cement is sometimes used for this purpose.

Cinder concrete should not be used in contact with copper. Where copper is used in this type of construction the concrete should be painted with a heavy coating of asphalt paint before the copper is applied.

FLASHING OLD AND NEW WORK

Where a new building adjoins an old one it is necessary to flash properly the joint between the two so as to prevent water running down between them. The new wall may be higher, or lower, than the old, or the walls may be even. Methods of flashing will necessarily differ. It is necessary to provide a water-stop and allow for the settlement that is bound to occur.

A method of handling the three cases named is described in paragraph 79, page 41, of the specifications. The cap referred to in Alternate (–3) is that shown in Figs. 67, 69, and 70.

When conditions different from these are encountered special methods of flashing must be devised, keeping in mind the movement to be expected after the flashing has been done.

WOOD SHEATHING

Wood sheathing is of great importance in flashing work. Green or wet boards shrink and warp and cause cracks and wrinkles in the metal covering. The ideal sheathing is of kiln-dried boards. These are, however, rather expensive. Satisfactory results can be had with stock boards provided allowance is made in laying for movement. After laying sheathing should be protected against rain, and no metal should be laid before the boards are thoroughly dried out.

Ship-lap is better than tongue-and-groove boards. It is easier to lay and there is practically no trouble from warping and swelling.

All boards should be well-nailed at every bearing and separated slightly to allow for the swelling that comes with dampness. All exposed nail heads should be sunk.

BUILDING PAPER

Under all flashings, in built-in gutters, etc., use building paper. Rosin-sized felt weighing about 6 pounds per 100 square feet is recommended. On narrow flashings, it is not absolutely necessary. Over rough surfaces, such as concrete, etc., it must be used as a protection against abrasion. When used with mason work, which is subject to discoloration, a black waterproof-paper should be used. (See page 45.)

For fireproof construction the National Board of Fire Underwriters recommends an asbestos-felt paper about one-sixteenth of an inch thick, weighing approximately fourteen pounds per hundred square feet.

"SOFT" AND "HARD" COPPER FOR FLASHINGS AND GUTTERS

Copper sheets are made in varying degrees of temper, or hardness. Experience has definitely established the two which are best suited for flashings and for gutters and leaders. The building profession has come to know these two as "soft-" or "hot-rolled," and "hard-" or "cold-rolled" copper, and it is common practice to so designate the sheets in specifying or ordering.

It can be readily understood that because there are different degrees of temper mistakes often occur due to the confusion arising from ordering, for instance, "16-ounce hard-rolled copper." The question the manufacturer asks is "how hard"? for the process of manufacture is dependent upon the results desired.

Copper sheets are made from "cakes," which, after being heated to the required temperature, are passed through rolls until the desired thickness of sheet is obtained. The first part of the process is the same for all tempers. When the copper has cooled below a workable temperature, it is again heated and rolled, this procedure being carried on until the sheet is within a few gage numbers, or thicknesses, of the finished product.

If the material is to be "soft-" or "hot-rolled" it is again heated and rolled to the required thickness, and then given a final heat or "anneal" to remove the hardness acquired by rolling.

The hardness of sheets is determined by the reduction in thickness before reheating. So, depending upon the temper or degree of hardness desired, the sheets are brought to certain thicknesses which will give the required final thickness with the necessary rollings, are then heated to the proper temperature, and are finally rolled to the desired thickness—and hardness—and allowed to cool.

From the above process it is obvious that unless the temper, or hardness, is definitely specified, or the purpose for which the sheet is to be used is described, the manufacturer has not the information necessary to supply the proper material. As the result of the confused use of terms, sheets of a hardness ill-adapted to the service desired have sometimes been used, with disastrous effect.

As mentioned above there are two hardnesses of copper which are adapted to use for roofing purposes. The manufacturer knows from experience what these degrees of hardness are. They are designated as "roofing temper" and "cornice temper." The former is a "soft-" or "hot-rolled" product, the later a "hard-" or "cold-rolled" one.

In order to prevent misunderstanding and confusion, and to make as definite as possible the kind of copper desired, it is recommended that the

trade and architectural profession adopt the following terms:

Instead of	**Use**
Soft Soft-rolled Hot-rolled	Soft (Roofing Temper) *abbrev.* (*R. T.*)
Hard Hard-rolled Cold-rolled	Hard (Cornice Temper) *abbrev.* (*C. T.*)

All flashings of whatever description should be of soft (roofing temper) copper sheets. Such copper is peculiarly suitable for this use for it is easily worked and shaped and stands up well under temperature stresses. There is no place in flashing —or counter-flashing—where soft (R. T.) sheets will not serve better than hard (C. T.) copper. The latter, being comparatively hard, does not lend itself so readily to shaping on the job. The softer the copper the easier it is worked and shaped and the more readily it adjusts itself to changes in size caused by expansion and contraction.

For the opposite reason the material of all shaped gutters, eaves trough, drips, water-bars, leaders, cornices, etc., should be hard (cornice temper) copper. Its stiffness is necessary to maintain the shape, especially against ice and snow loads. As most shapes are of mill-manufacture the process is such that the chance of fracture at the bends is minimized.

In fact, all manufacturers of gutters, leaders, etc., make them of hard (C. T.) copper, because experiment and experience have proved their practicability.

To this general rule there are two exceptions, gutter-linings and cornice ornaments. These should be of soft (R. T.) copper.

Gutter-linings in gutters of any length are peculiarly subject to temperature stresses. The continual warping to which the sheets are subjected soon fatigues hard (C. T.) sheets, and cracks develop at the bends. The use of a softer sheet overcomes this cause of failure.

For ornaments which are stamped from dies soft (R. T.) copper is superior to hard (C. T.), for the former works more easily and is less liable to fracture.

WEIGHT AND GAGE OF SHEET COPPER

Copper sheets are made in all weights and gages up to one-quarter inch, thicknesses greater than which are usually classed as plates or slabs. It is generally defined by the ounce weight per square foot; that is, "16-ounce copper" means copper weighing 16 ounces or one pound per square foot.

Experience has proven that 16-ounce copper sheet is the ideal flashing weight. Under special conditions, such as unusual exposures to wind or snow, this weight may well be increased. Some architects will specify nothing lighter than 18-ounce material. On roofs with heavy tiles or slates 20-ounce is advisable, for a lighter metal is too easily cut by the heavy roofing.

Flashings lighter than 16-ounce are undesirable. Sixteen-ounce copper is 0.0216 of an inch thick; 14-ounce is less than 2/100s of an inch, and is easily punctured by heels, etc.

All rain water carries with it off the roof dust and grit particles, which have some wearing effect on the gutter. It becomes wisdom to use metal thick enough to do the work of leading off the water for a period of time at least as long as the life of the building. Sixteen-ounce copper will stand up under these conditions; fourteen-ounce is too light.

Built-in flashings of closed valleys, when the flashing is itself protected by the roof covering, might, with a light form of roofing, be of metal lighter than 16-ounce, but as a matter of good practice it is recommended that nothing lighter than 16-ounce be used for flashings, gutters and leaders.

TABLE I

Weights of Sheet Copper in Pounds Per Square Foot

Rolled Copper has specific gravity of 8.93. One cubic foot of Copper weighs 558.125 lbs.

Thickness in Stubs' Wire Gage	Thickness in Decimal Parts of an inch	Approximate Equiv. Thickness in Mm.	Weight per Sq. Foot in ounces	Weight in Pounds of Sheet 14 x 48 in.	Weight in Pounds of Sheet 24 x 48 in.	Weight in Pounds of Sheet 30 x 60 in.	Weight in Pounds of Sheet 48 x 72 in.
35	.00537	0.127	4	1.16	2	3.12	6
33	.00806	0.203	6	1.75	3	4.68	9
31	.0107	0.254	8	2.33	4	6.25	12
28	.0134	0.356	10	2.91	5	7.81	15
27	.0161	0.406	12	3.50	6	9.37	18
26	.0188	0.457	14	4.08	7	10.93	21
25	.0215	0.508	16	4.66	8	12.50	24
24	.0242	0.559	18	5.25	9	14.06	27
22	.0269	0.711	20	5.83	10	15.62	30
21	.0322	0.813	24	7.	12	18.75	36
19	.0430	1.067	32	9.33	16	25	48
18	.0538	1.245	40	11.66	20	31.25	60
16	.0645	1.651	48	14.	24	37.50	72
15	.0754	1.829	56	16.33	28	43.75	84
14	.0860	2.108	64	18.66	32	50	96
13	.095	2.413	70		35	55	105
12	.109	2.769	81		40½	63	122
11	.120	3.048	89		44½	70	134
10	.134	3.404	100		50	78	150
9	.148	3.759	110		55	86	165
8	.165	4.191	123		61	96	184
7	.180	4.572	134		67	105	201
6	.203	5.156	151		75½	118	227
5	.220	5.588	164		82	128	246
4	.238	6.045	177		88½	138	266
3	.259	6.579	193		96	151	289
2	.284	7.214	211		105½	165	317
1	.300	7.620	223		111½	174	335
0	.340	8.636	253		126½	198	380

(*Continued next page*)

TABLE I (Continued)

Approximate Weight of Sheet Copper per Square Foot in Fractional Parts of an Inch

$\frac{1}{16}$ inch thick weighs	3	pounds to the square foot
$\frac{1}{8}$ " " "	6	" " " "
$\frac{1}{4}$ " " "	12	" " " "
$\frac{1}{2}$ " " "	24	" " " "
1 " " "	$46\frac{1}{2}$	" " " "

To Ascertain the Weight of Copper.—Find the number of cubic inches in the piece, multiply by 0.3214, and the product will be the weight in pounds. Or, multiply the length and breadth (in feet) and that by the pounds per square foot.

These weights are theoretically correct, but variations must be expected in practice.

CRIMPED COPPER

The use of crimped copper is well-established, and on the best work it is recommended.

Crimped sheets can be obtained from any of the large mills by special arrangement. Many of the larger roofing firms are also equipped to do this work.

The crimps consist of 3/16 inch V-shaped corrugations running cross-wise with the length of the sheet.

Crimping is expensive. It reduces the size of the sheet, and there is, of course, a charge for the labor involved. The process tends to harden the copper. The amount of hardening is, however, not great.

Its chief advantage is in its behavior under temperature changes. The crimps make splendid expansion joints. For this reason its use in large built-in gutters, where fastenings are difficult to make and small sheets are inadvisable, is well worth consideration.

Crimped copper is extensively used for cornice work both for ornamental and practical reasons. It gives a nice finish to the plane surfaces of the cornice and the crimps allow opportunity for expansion and contraction.

SIZE OF SHEETS FOR GUTTERS

Small sheets are generally used for lining gutters and decks, pans, etc. Large sheets are more difficult to handle than are small ones. Because they are closer together and there is only a small amount of cumulative expansion, the strain on the seams and cleats is minimized by the use of the small sizes.

When small sheets are used more seams and more labor is necessary. This is the one objection to their use. A method of strengthening the seams of long sheets used in gutter-linings has been used successfully. It is recommended for gutters generally, and particularly in masonry work where the setting of wood nailing-pieces for small sheets means a considerable expense. The ends of the long sheet, which are laid the long way of the gutter, are flat or double-locked to 4-inch strips laid across the gutter. The two seams thus formed are fastened with cleats to one nailing piece.

The length of any sheet or strip should not exceed 8 feet. The width depends upon the type of flashing. In general, decks, crickets, and similar large flat spaces on roofs are covered with small sheets, about 18 inches by 24 inches, or 20 inches by 30 inches. The size of sheets used in gutter-linings depends largely upon the design of the gutter. There is no hard and fast rule.

BUILT-IN OR BOX GUTTER LININGS

For best results in gutter-linings the following practice is recommended.

(1) The design of the gutter should avoid sharp angles. The sides should slope as much as possible to approximate an arc. The inside edge of gutter should be at least 3 inches higher than the outside edge. Gutters should be as shallow as possible.

(2) The gutter should be wood-lined to receive the copper.

(3) Sixteen-ounce soft (R. T.) copper sheets which have been crimped are excellent. Their length is optional up to 8 feet maximum; their width should not exceed 36 inches.

(4) Longitudinal seams should be double-locked. This provides strength at the seam and with (3) allows plenty of opportunity for expansion.

(5) Seams should be well-soldered.

(6) The junction with the roof flashing should be by a large loose-locked joint so placed as to need no solder to make it water-tight.

(7) If long sheets are used a double-cross seam should be used. The construction of this is described above.

INNER-LININGS FOR MOLDED GUTTERS

In long runs of molded gutters (such as is shown in Fig. 93, page 63) it is sometimes necessary to install false bottoms, or inner-linings, in order to get the proper slope to the outlet. This

is done because the gutter itself must be hung level and true to form the cornice. When such inner-linings are used they are formed of not less than 16-ounce copper to fit the contour of the gutter and are set in place and soldered to the sides to provide a sloping floor to the outlet. Where possible, such construction is to be avoided as it is expensive both from a material and labor standpoint. It will generally be found more economical to design the gutters with enough outlets to make inner-linings unnecessary.

SIZES OF SEAMS

The development of a standing seam is shown in Fig. 72. To form a standing seam the sheets of copper are prepared by turning the edges of the sheets at right angles, $1\frac{1}{4}$ inches on one edge and $1\frac{1}{2}$ inches on the other edge. Then (1), two sheets are placed together on the roof with the $1\frac{1}{4}$-inch face of one against the $1\frac{1}{2}$-inch face of the other. (2) The projecting $\frac{1}{4}$ inch of the $1\frac{1}{2}$-inch face is turned completely back (180°) on the $1\frac{1}{4}$-inch face of the other. (3) The two sheets thus joined are then turned again 90° and, (4) then again 90°, and the folds pressed tightly together. The seam thus formed finishes 1 inch high. A $\frac{3}{4}$-inch finished standing seam is made by turning the edges 1, and $1\frac{1}{4}$, inches.

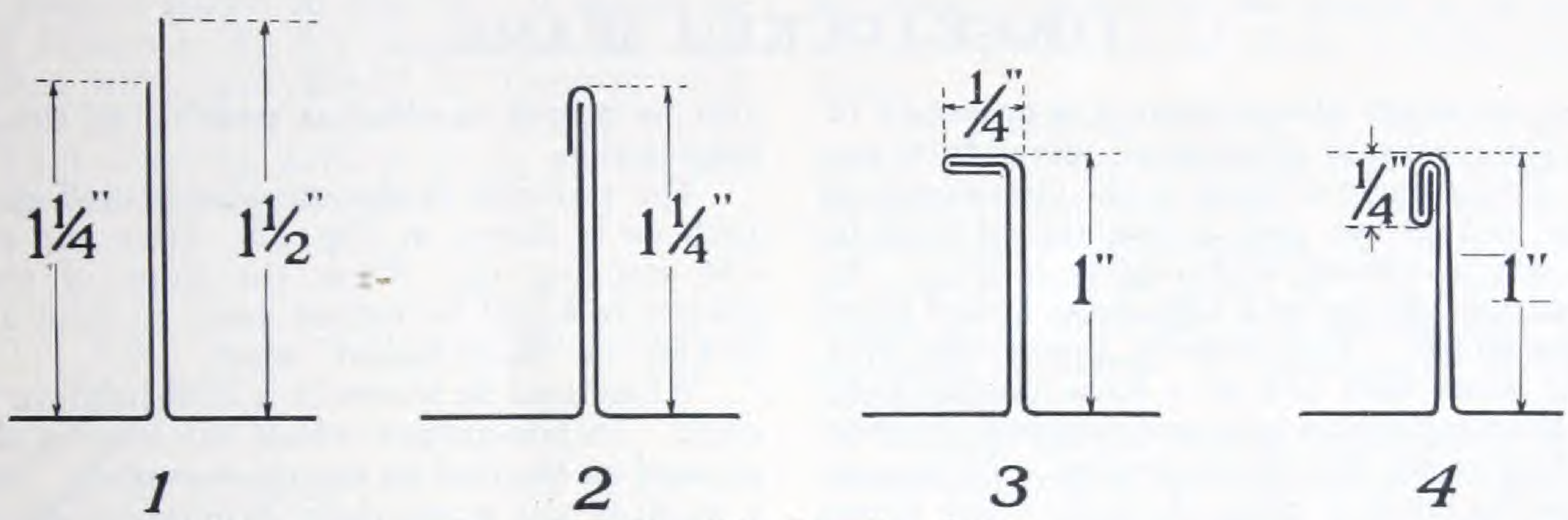
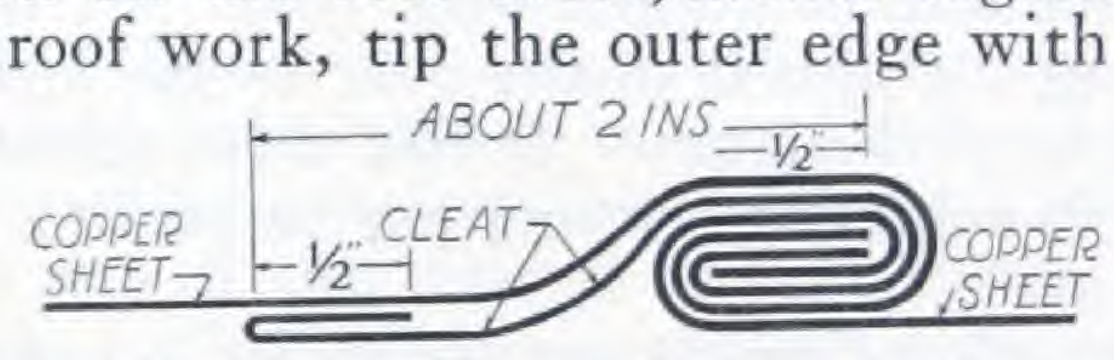


Fig. 72. The Standing Seam

A double-lock flat seam or copper-lock is shown in Fig. 73. To avoid confusion the cleats necessary to hold the seams to the roofing are omitted. The steps in forming this seam are as follows: (1) Bend the edges of the sheets at right angles, one edge $1\frac{1}{4}$ inches, the other $1\frac{1}{2}$ inches. (2) Place the sheets together, a $1\frac{1}{4}$-inch edge against a $1\frac{1}{2}$-inch edge. (3) Turn the $1\frac{1}{2}$-inch edge 180° down on the $1\frac{1}{4}$-inch edge. (4) Turn both together again, in the same direction, another 180° and then, (5) turn both in the same direction 90° down on the roof sheet, mallet together and, on flat roof work, tip the outer edge with solder.



Fig, 73. A Double or Copper-lock seam

The method of securing copper sheets by cleats and a single-lock flat seam is shown in Fig. 74.

Fig. 74. A Single-lock Flat Seam and Cleat

The steps in the process are as follows: (1) Tin the edges of the sheet. (2) Bend the edges of the sheets at right angles. (3) Place the sheet with the short bend on the roof. (4) Place the cleat against the sheet and nail the cleat to the roof and turn the end back over the nails. (5) Place the second sheet in position and, (6) turn the edge of the second sheet and the cleat 180° down over the edge of first sheet. Then, (7) turn all together 90° in the same direction down on the first sheet, flatten and solder.

Fig. 75 illustrates the lap seam. The edges of the sheets are tinned $1\frac{1}{2}$ inches, placed in position, and soldered. Lap seams are often made less than 1 inch wide, and in places where there is little or no strain on the seam, a $\frac{1}{2}$-inch lap may well prove sufficient. All lap seams on flashings where there is any likelihood of strain should not be less than 1 inch.

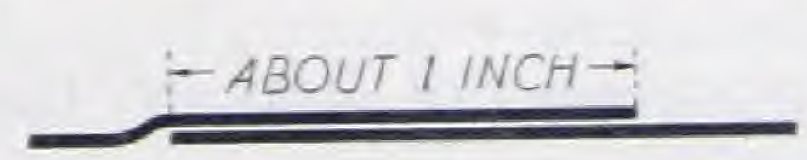


Fig. 75. A Lap Seam

SEAMS IN CAP AND BASE FLASHINGS

Cap flashings against walls are usually made in 8-foot strips. The ends are lapped about 3 inches to form a cross seam, no soldering being necessary.

The seams in base flashings are of the flat type (see Fig. 74). They are about 8 feet apart, and should be so spaced that they do not occur with the seams in the cap flashing. The seams are made as is usual in flat seam construction and should be lapped in the direction of the flow so that no water will enter them. The ends of the sheets are tinned and sweated full of solder.

The double or copper-lock is sometimes used in this construction. (See Fig. 73).

SLOPES OF ROOFS

Roofs with a slope over 15° to the horizontal are called steep roofs. This slope is about 1 on 4. On such slopes, or steeper ones, no solder is necessary in the joints and seams, as the locking and flattening is water-tight.

Where there is a sudden change of slopes, as occurs at the intersection of two planes, large surfaces of copper should be connected by a large, free-moving locked joint, unsoldered.

LOOSE-LOCKED SEAMS

There are many places where it is necessary to provide for expansion where usual methods do not apply. Particularly is this so at the intersection of different roof planes and at the top of built-in gutters which connect with copper roofing. At these locations the use of a large loose-locked seam is recommended. This consists, practically, of a standing seam bent flat, or a loose double lock. It acts as an expansion joint and prevents creasing and folding at the line of intersection. Of course, care must be taken to place the lock, which is not water-tight, so that it will not leak. It should also be placed as close as possible to the line of intersection.

The principle is the same as is used on decks, such as is shown in Fig. 22. Here the seam is left standing up. Were the slope of the roof greater it would be turned down to form a "free-locked" or "loose-locked" seam.

When used as shown it is held in place with a cleat. In box-gutters where the roofing sheet is secured on the roof no cleat is necessary. As such a seam is not water-tight it must, of course, be located above the outside edge of the gutter.

THE DOUBLE LOCK OR COPPER-LOCK

The double or copper-lock (Fig. 73) is made by folding the joined sheets over twice, instead of once, to form the seam. It has these advantages.

1. No soldering is necessary to make a water-tight joint.

2. It allows ample provision for expansion.

An objection is that it uses more copper than does the single lock, 2½ inches being needed instead of 1½ inches. This amounts to about 7% of a 24 by 30-inch sheet. However, this loss is compensated by the saving in soldering.

A second objection is that water is liable to work its way under the unsoldered edge, freeze, and open the seam. This can be overcome by making seams with the slope and by tipping those on flat surfaces with solder along the outer edge. If properly malleted down this is unnecessary.

A third objection is that the number of folds, 21 in all, at the corner of a sheet staggered with adjoining ones, make a hump in the seam. This can be overcome by special notching, or by using the single lock on one set of seams.

Its merits are such as to recommend it for all work, and especially for large built-in gutters where expansion is difficult to handle.

FASTENINGS FOR FLASHINGS

Fundamental in installing copper flashings are proper fastenings.

A good rule to follow is:

I. All fastenings of copper must be of copper or brass.

This rule applies not only to nails but to gutters, hangers, brackets and braces, and to screws, rivets and washers.

When steel or iron (either plain or galvanized) is used with copper work a galvanic action takes place between the copper and the other metal which quickly destroys the latter.

Two equally important rules are:

II. Never secure copper in any manner which will prevent its free movement.

III. Fasten copper flashings over 12 inches wide by cleats. Do not nail.

The greatest source of trouble from failure to observe these two simple rules is in valley flashings. These, by their very nature, are usually from 16

to 24 inches wide, and must be secured on both sides. Fig. 6 shows a valley flashing. If the sheet is 18 inches wide the lateral movement through extreme temperature ranges is about 1/50 of an inch. Where such movement occurs two things may result. A nailed flashing tears at the nails and becomes loose, or the sheet buckles along the edge of the roofing material. As a result of the first, water works under the loose flashing. With the second, failure occurs by splitting or abrasion.

This trouble is avoided by securing flashings with cleats. The cleats are nailed, it is true, but Rule II is observed. The large sheet, not being held fast anywhere, moves freely and the cleat takes up the movement.

There are other methods of doing away with this trouble, one of which is shown in Fig. 7. Here the sheet has a ½-inch fold under the roof covering. This fold takes up any movement in the sheet. However, it is open to this objection. In applying the roof the fold is liable to become well-flattened, so much so that the metal may receive a surface crack. With subsequent movement—the result of temperature changes—the cracks open and in time the sheet may fail at the fold—just where the water can get under the flashing.

If this construction is used care must be observed during laying, to protect the fold against this creasing or flattening.

CLEATS

The cleat is shown in Fig. 76. It should be made of 16-ounce (R. T.) copper, not less than 1½ inches wide, and should be fastened with two copper nails. The end of the cleat should be turned back over the nails so as to prevent the nail heads from cutting the sheet.

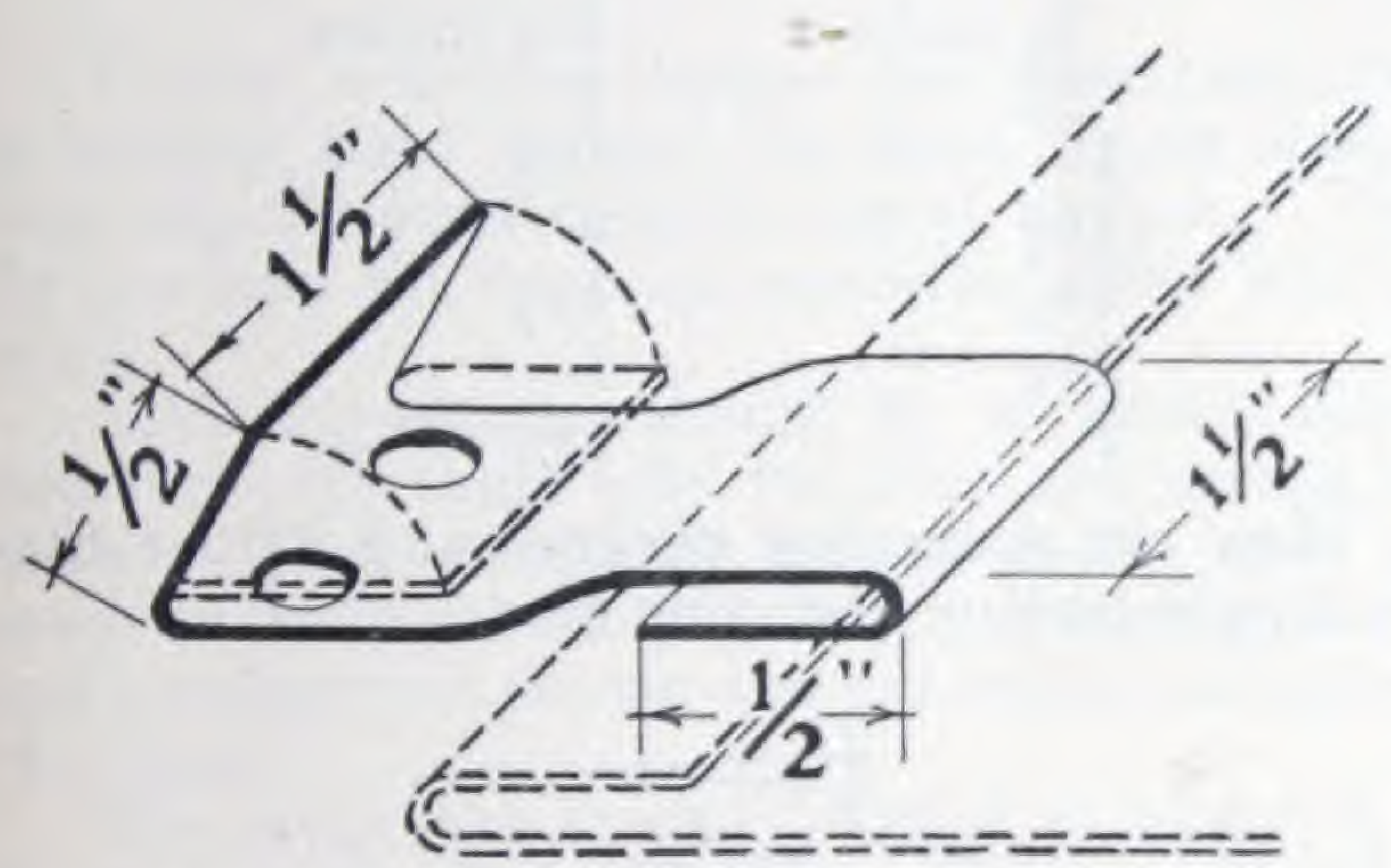


Fig. 76. The Cleat.

The length of the cleat is determined by the kind of seam with which it is used. It should be about 3 inches for flat seams so as to allow the nails to be placed about 2 inches from the seam.

The maximum spacing of cleats should not exceed 12 inches; a spacing of 8 inches is recommended for the best work. This does not apply to concealed valley flashings, etc., where the sheet or strip is held in place by the roof covering. Under these conditions the spacing may be considerably increased. A maximum of 24 inches is recommended.

In applying the cleat a copper sheet is placed in position with a half inch bend at right angles to the roof. Then the cleat-strip is set against it with one inch of the tinned end bent at right angles to the roof on which the other end rests, and with the turned end of the cleat against the turned edge of the sheet which has also been tinned. The next step is to turn the tinned end of the cleat down and over the edge of the sheet and then again turn both down on the surface of the sheet. Then the cleat is nailed to the roof and the last half-inch of the nail end of the cleat is turned back over the nail heads. If the cleat also secures a second sheet it is laid as described in Fig. 74, page 49.

NAILS

There are some flashings which, of course, must be nailed. Those around windows and doors, gravel-stops, etc., are secured in this way. Figs. 8, 10 and 37 show these conditions. In every case it will be noticed that Rule I (page 50), has been observed. The flashing strip is only fastened along one line. It is free to move toward and away from the line of nailing. The longitudinal movement is taken care of by placing the nails a short distance apart and by the use of soft (R. T.) copper. The movement during a temperature change of 120° with a nail spacing as great as 12 inches would be only 12/1000, less than 1/64, of an inch; an amount easily taken care of by the soft copper sheet.

It would seem that the use of copper nails with copper sheets is so well-established as to be axiomatic. Unfortunately this is not the case. The danger of using iron or steel nails with copper can not be over-emphasized.

The proper nails to use with flashings are large flat-head wire nails. (Fig. 78.)

These differ from the ordinary wire nail in the shape and size of the head. As can be seen from a comparison of Figs. 77 and 78 the ordinary wire nail has a ridge under a small head; this makes it impossible to drive the nail home without injuring the sheet. The large flat-head wire nail is especially made for fastening copper sheets.

For all ordinary work No. 12 gage wire nails are recommended.

Figs. 79 and 80 show cut nails of copper such as are regularly used for roofing. The disadvantages of these can be readily seen. The shank tears the sheet and the head, if driven home, makes a further tear, so that the sheet is badly cracked about the nail-hole.

In exposed positions where wide flashings or gutter-linings are subject to violent wind storms, or in factories or mills where the wood sheathing is likely to dry out quickly because of heat from the interior of the building, heavy (10 gage) wire nails, with barbs cut in them the full length of the shank are recommended to hold the copper securely in place.

Such nails can be furnished quickly by jobbers or manufacturers. They carry an extra of approximately ½ cent a pound over the usual list on kegs of 100 pounds. Smaller quantities are furnished by arrangement only.

Table II shows the sizes and list prices of copper nails suitable for flashings.

Fig. 77
Copper Wire Nail. (Similar to Steel Wire Nails)

Fig. 78
Large Flat-Head Copper Wire Nail. (Slating and Shingle Nail)

Fig. 79
Regular Cut Copper Nails.

Fig. 80
Large Flat-Head Cut Copper Roofing Nail

[Note difference in head of ordinary wire nail (Fig. 77) and large flat-head wire nail (Fig. 78)].

TABLE II

Extras Over Base Price

For

Large Flat-Head Copper Wire Nails

Length in inches........	⅞	1	1¼	1¼	1¼	1½	1½	1½
Gage (Stubbs)..........	12	12	10	11	12	10	11	12
Extra over base per lb....	2c	2c	—	—	— B	ase	—	—
Approx. No. of nails per lb.	303	278	....	196	231	134	....	210

These prices for kegs of 100 lbs. or over. Add the following extras for less than 100 lb. lots.

75 lbs. to 100 lbs.......................................2c. per lb
50 lbs. to 75 lbs.......................................3c. " "
25 lbs. to 50 lbs.......................................5c. " "
Less than 25 lbs.......................................10c. " "

Brass nails are also used where a non-corroding fastening is needed. They are particularly adapted for slate and tile roofs where large cut nails are necessary.

Brass nails are made only as cut nails in the following sizes:

¾ inches	2½ inches
⅞ "	3 "
1 "	3½ "
1⅛ "	4 "
1¼ "	4½ "
1½ "	5 "
2 "	5½ "

They are somewhat cheaper and harder than are copper nails of the same kind.

Fig. 81

Fig. 81 illustrates copper and brass tacks such as are used for fastening canvas decks, etc.

TINNING

The edges of sheets to be soldered must be carefully tinned wide enough for proper soldering. New block tin should be used and, if possible, the sheets should be dipped in the molten tin in the shop rather than tinned with a soldering-copper on the job.

The flux used should be the same as that used for soldering. For tinning on the roof heavy coppers are essential for satisfactory results.

Tinning can be done at the rolling mills. Where it is possible to estimate in advance the amount of tinning necessary it is often advantageous to have the work so done. It insures good results and an even distribution of tin.

It is difficult to determine in advance the quantity of tinned sheet necessary for a job, and there is, accordingly, the uncertainty of ordering too much or too little.

FLUX

The use of killed acid as a flux is universal and, in the majority of cases, successful. Nevertheless, its use should be avoided as the chances of injury to the sheets are great. Acid flux of an improper kind will do irreparable damage to the finest workmanship.

Rosin is recommended as a flux. It is harmless to the metal and makes good seams. It takes more labor but it is safe. There are some objections to its use, such as sloping roofs and windy days. Under these conditions it is much easier to use killed acid for it will not blow away and it

will stay on the slope. But it will run down a slope and it will spatter on windy days. Rosin can be kept in place by "burning" it on with a small soldering copper just hot enough to melt the rosin. Powdered rosin in gasolene is recommended.

The proper preparation of acid for use as a flux is of the greatest importance. It is not a job to be entrusted to a novice. The acid used is hydrochloric (or muriatic). Pieces of zinc are put in the quantity to be used until it stops working; then it is properly killed. If the killing is done hastily or by anyone not familiar with the procedure, the acid is used in a still active state and attacks the copper. Pitting ensues and the work is spoiled. The acid to be used for an entire job should be prepared several days before the work starts and allowed to stand.

SOLDER AND SOLDERING

The only solder which should be used is the best "half-and-half" obtainable. It must be composed of new tin and new lead.

The weakness of any composite structure, be it steel bridge or copper roof, is in the joints. These must be made tight and strong. The best way to make them strong is to use wide, well-sweated seams. Excellent results have been obtained with seams two inches wide; that is, with the solder flowed over that much. A good full inch is none too wide. Lots of solder, well-flowed over, is the secret of strong seams.

Soldering should be done slowly with thoroughly heated coppers, so as to heat the whole seam uniformly and to insure the complete amalgamation of the tin and the solder.

SOLDERING-COPPERS

Proper soldering-coppers are most important in making tight seams. As sheet copper absorbs heat rapidly light coppers are of no use. They do not hold the heat nor soak the solder into the seam.

Soldering-coppers should be of heavy, blunt-end type, for these hold the heat and spread the solder. They should be moved slowly over the seam so as to thoroughly heat the copper sheets and amalgamate the tin and the solder soaked into the seam.

The same flux should be used in soldering as is used in tinning the edges. Coppers should be properly tinned before use, and, of course, care must be used in heating to avoid burning either the tinning or the copper. Coppers must be hot through and through but not overheated.

For upright seams pointed soldering-coppers should not be used because there is not sufficient heat in the point to heat the sheet and spread the solder. For these a flat chisel-point pattern, weighing not less than 6 pounds to the pair, should be used. For flat seams use a blunt square-end type of copper weighing not less than 10 pounds to the pair.

WHITE LEAD

White lead in oil is a good substance for filling lock seams in copper work. It is simple to apply, is watertight, and remains so a long time. White lead has been used on copper roofs, laid many years ago, both in this country and abroad. Notable among roofs of this type is that on the State House in Boston, Mass. This roof was laid in 1887–90 with leaded seams, and is apparently as tight today as it was thirty-five years ago.

The method of applying consists of smearing the edges of the sheets plentifully with white lead in oil and folding and locking them to form lock seams in the usual way. The viscous lead and oil completely fills the lock making a water stop.

White lead used in this way has much to recommend it. It is cheaper than soldering, and it is durable. On flat roofs where water backs up it is perhaps better to use solder, but on free-draining surfaces white lead can be used with every assurance of satisfaction.

EDGE ON EXPOSED FLASHINGS

It will be noted on the drawings that all exposed and unfastened flashings have the edge of the strip turned over ½ inch. This is done to give the strip stiffness against wind. Thus the sheet is held in place and the packing in of snow under the flashing is prevented. It is a practice that should be axiomatic with flashing.

BENDS IN COPPER

At all changes of direction or of the planes of roofs, such as where the roof of a dormer meets the main roof or the bottom of a built-in gutter turns up to meet the sides, special precaution must be taken to avoid breaks and cracks. Where copper sheets are confined in sharp angles there is a restraint of free movement and the copper warps and buckles. The sheet loses its ductility and in time fracture results. In fact a sharp bend in copper sheets is as bad as nailing for it stops the free "flowing" of the sheet and provides a place for a buckle to start.

This can be done away with by using small triangular blocks in corners and working the sheet over them in a gradual or easement curve.

Such construction makes it difficult for the roofer to make up the seams, for where the sheet is bent at an angle of less than 90 degrees it is necessary to notch out the seam, with the result that there is not a full seam with four thicknesses of copper (for flat seam construction) at the bend where the notch is made. This is not serious and can be overcome by careful soldering.

If the triangular blocks are not used, great care must be taken to avoid a crease in the copper at the bend. If the sheet is folded over on itself and then opened up—that is, if it is bent more than 90 degrees—a crease will form, which acts, under temperature change, as a hinge and ultimately cracks.

DRIPS, EDGE-, AND EAVE-STRIPS

At the outer edge of cornices and similar projections it is good practice to secure the flashings as illustrated in Figs. 12, 17, 18, etc., by means of edge-strips or drips. The two terms are used interchangeably to describe either the methods there shown or those in Fig. 82.

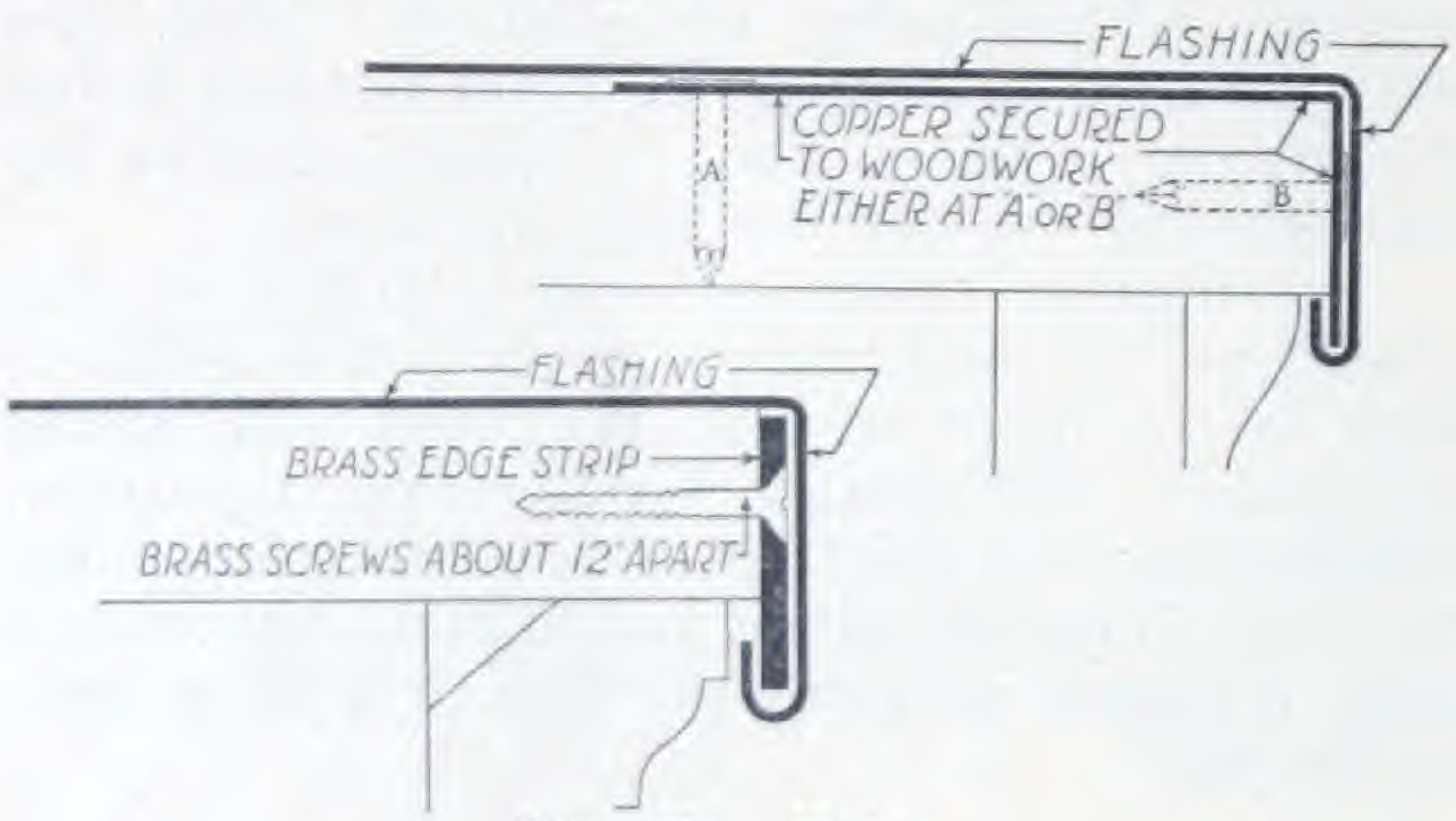


Fig. 82. Drips

Drips. A drip, when not formed by an edge-strip consists of a piece of copper (at least 18-ounce, preferably 24-ounce), nailed to the top of the sheathing or to the face of the molding locked to the flashing sheet as shown. It acts both as a fastening and a drip and is satisfactory for all purposes for which the heavier edge-strip need not be used.

Edge-Strips. An edge-strip consists of a piece of brass about 1/8 of an inch thick by 1 1/4 inches wide screwed to the supporting face by brass screws and placed so that the sheet can be hooked under it about 3/8 of an inch to form a lock. In most instances it is placed so as to project slightly below the sheathing or the upper fillet of the molding to form a drip. This form of construction is used where a stiff fastening and a straight true edge is needed. This type of edge-strip is used with large molded gutters and cornices of copper to provide the necessary strength and stiffness to the outer edge.

Eaves-Strips. When eaves and roof edges are finished with an ornamental molding which requires protection against water from the roof an eave-strip is sometimes used. It is made as described in paragraph 53, page 36, of the specifications.

CAULKING

The materials used for caulking joints around pipes and reglets in masonry work are elastic cement, sulphur and lead. The last named is the most satisfactory in every respect. It completely fills the space, holds the copper, does not disintegrate, adjusts itself to temperature changes.

On perpendicular surfaces, etc., where the pouring of molten lead is difficult, lead wool is used. It must be well caulked, and the joint completely filled. Molten lead should also be well caulked to insure a solidly-filled joint.

After caulking the reglets are sometimes smoothed and made flush with the adjoining masonry by filling them with elastic cement. This gives a neat appearance to the finished work.

EXPANSION AND CONTRACTION

The confusion that seems to exist regarding the expansion and contraction of copper—or, for that matter, any similar live metal—has brought about an unfavorable attitude in the minds of many people.

While no attempt is here made to belittle the importance of this feature of copper work the majority of failures attributed to expansion and contraction are actually the result of improper installation and failure to observe Rule I (page 50).

Copper must be considered as a "live" metal; i.e., one which not only moves under temperature variations, but also has a large amount of ductility and tenacity. It is this characteristic which allows the metal to "flow" while adjusting itself to temperature stresses, and prevents the occurrence of internal strains which result in failure. Too much emphasis can not be laid on this feature. Careful planning for it when applying flashings of copper means a satisfactory job.

A strip of copper measuring 1 inch at 60° F. when cooled to 0°F will contract in length an amount equal to L x 60 x .0000095, or 0.00057 inches, and the length of the strip will become 0.99943 inches. If the temperature is increased from 60°F to 120° the length will become 1.00057 inches. Assume that the copper strip is held securely to its original length. The modulus of elasticity of annealed copper is 18,300,000. The stress in the strip due to a change in temperature of 60° may be computed as follows. F = E x N, where E is the modulus of elasticity and N is the linear change. 18,300,000 x .00057 = 10,431 pounds per square inch. As the breaking strength of annealed copper is 36,000 pounds per square inch and the yield point somewhere in the neighborhood of 20,000 pounds, it is evident that in a range of 120° F change in temperature (from 60° down to 0° and up to 120°) the factor of safety varies from 2 to 3½.

Were all copper applied at a temperature not greater than 100°F there could be no failure directly due to expansion and contraction, for the elastic limit and the breaking strength would never be exceeded (in a range to −20°), and there would be no stretching of the copper.

Sometimes, undoubtedly, the temperature of the sheets at the time of laying is slightly greater than 100°, and the temperature range on roofs is large, measuring in one instance 170°, from −20° to 150° above zero.

However, even under these extremes, copper does not fail, because it is not stressed to the breaking point. All building materials expand and contract, and the change in length of any one is relative to others to which it is attached. The coefficient of expansion of concrete is 0.00000795. copper laid in a concrete gutter has a coefficient, therefore, of .0000095 − .00000795, or 0.00000155, and the stress in copper laid at a temperature of 100° is, at −20°, only about 3,400 pounds per square inch, giving a safety factor of from six to ten. When laid on wood, which has a small coefficient, the stress on copper is within the bounds of safety.

If the stresses due to expansion and contraction alone are considered it must be apparent that the failure of copper due to temperature changes alone is an extremely rare occurrence. When, however, a sheet is partially constrained, and a point is provided where the cumulative movement due to temperature changes can create a hinge action, fatigue will eventually destroy the ductility of any metal and fracture will ensue.

EXPANSION JOINTS

Large steel-framed structures are usually built with expansion joints to allow for movement in the frame. Where copper-lined gutters or cornices, etc., are used with this type of structure it is necessary to provide expansion joints at the points where they occur in the building.

These are built in the usual manner, as is shown in Fig. 83. The gutter-linings are turned up normal to and slightly higher than the depth of the gutter, the ends are bent at an angle of 90 degrees to the vertical, and a cap is locked over the top. The joint is designed to allow a small space (say ½ inch) between the vertical sides when fully expanded, and the length of the flanges and width of the cap is calculated to take care of the full contraction of the metal.

This type of expansion joint is sometimes used in large built-in gutters to provide for movement in the copper. These are spaced from 25 to 50 feet apart, and are claimed by their exponents to be the only solution of the "built-in-gutter" problem.

It is doubtful if these claims are substantiated. When copper is locked to the roof covering and to a cornice-strip in such manner as to provide a water-tight joint it is extremely doubtful if the

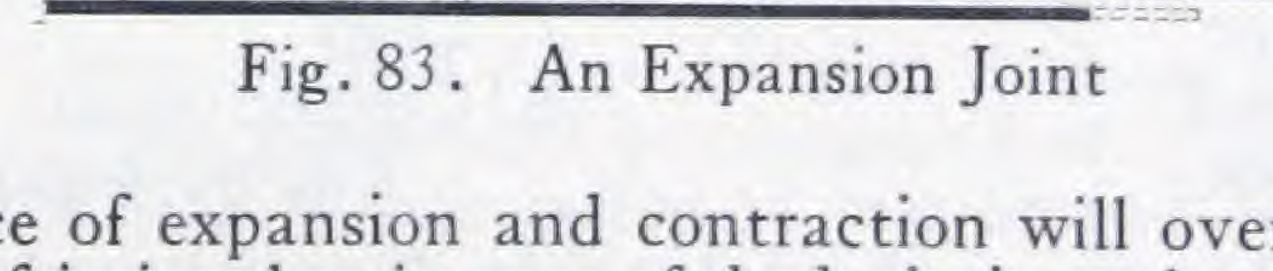


Fig. 83. An Expansion Joint

force of expansion and contraction will overcome the frictional resistance of the locks in such manner that the whole amount of movement will evidence itself at the expansion joint. A 50-foot stretch of gutter would move nearly ¾ of an inch during normal seasonal variation of temperature. This represents a change in length of 1/64 of an inch per foot, an amount which is easily taken care of at the seams of the individual sheets.

Especially is this true when one considers that this expansion is relative to the supporting structure, (as discussed elsewhere), and that the actual change in dimension per foot is seldom more than 1/200 of an inch.

Expansion joints are of no use when a gutter is built as in Figs. 53 and 54, where it is necessary to use a reglet to prevent leakage. Where this can be done away with, and the gutter-lining can be locked to the roof and cornice, an expansion joint can be used with some degree of success.

SCUPPERS

One of the most important points of roof drainage design is often forgotten. This is proper provision for overflow by means of scuppers.

A great many buildings have flat roofs enclosed by parapet-walls and inside drainage-systems. When the outlet becomes clogged water collects on the roof and not only causes an overload, but also works its way over the flashing and down into the building. The appearance of leaks of this character is often the first warning of the dangerous condition of the roof.

On all roofs of this character—that is, where there is not ample provision for escape of the water when the leaders do not work, it is absolutely necessary to provide scuppers through the wall. These should be large enough to preclude any possibility of clogging (at least 4″ x 12″), and should be unobstructed in any way by screens, etc. For a further description, see Figs. 36 and 58.

When copper flashings are used the scuppers are completely lined with copper and this lining is soldered to the base flashing, the counter-flashing being worked around the hole, or omitted at this point.

Scuppers must also be used to drain all balconies or similar small areas enclosed by a balustrade or wall.

EROSION

In some localities it is general practice to omit gutters from small flat roof dormers, or similar construction, and allow the water from the dormer to fall to the roof below. When the roof surface receiving the falling water is flat, or nearly so, the force of the descending water is often great enough to drive it under the roof covering. A special flashing is sometimes used to overcome this difficulty. Such practice is not good as the wearing effect of the water erodes the metal. When this is galvanized iron or tin corrosion destroys the iron base as soon as the thin protective coat of zinc or tin is worn away. Sixteen-ounce copper subjected to this erosion has withstood it for sixteen years before failure. Gutters and leaders should be used whenever water from one roof discharges on another roof below.

COPPER AND OTHER METALS

Dissimilar metals, when in contact in the presence of an electrolyte, set up galvanic action which results in the deterioration of the most electropositive metal. Starting with the most electropositive the commercial metals are listed as follows:

1. Aluminum (most Electro-positive)
2. Zinc
3. Steel
4. Iron
5. Nickel
6. Tin
7. Lead
8. Copper (most Electro-negative)

This means that when iron (or steel) and copper are in contact with an electrolyte present (which may be water) the iron is corroded. When copper and lead or tin are in contact a tendency for similar action exists but it is very slight and produces practically no injurious results. This is because the difference in potential is much less and the corrosive action is negligible, especially where water is the electrolyte.

Any possibility of galvanic action between copper and iron or steel should be carefully avoided by proper insulation. This insulation is effected in various ways, three of which are, (1) covering the steel member with asbestos, as is frequently done in skylight construction; (2) placing strips of sheet lead between the two metals, as when new copper gutters are placed in old iron hangers; and, (3) heavily tinning the iron, as is often done with iron or steel gutter and leader supports.

PART THREE

Supplementary Data

COLORING COPPER

Copper may be given different finishes by the use of various chemicals. The most commonly known and used of these are set forth below.

The Research Staff of the Copper and Brass Research Association will be glad to advise those who desire special finishes.

1. Bronze or Brown.

Clean off all dirt and traces of acid or other flux carefully. Give the cleaned copper a thorough coating of boiled linseed oil. Touch up the seams with copper bronze.

This can be applied with a mop or brush or with rags. This treatment makes the copper turn a dark brown color somewhat similar to old bronze.

How long this color will last, especially near salt air, is problematical. There are examples of it six or more years old. It is best to renew the treatment every two or three years unless the atmosphere is generally clear and dry. By this means it is possible, after a few treatments, to retain the color permanently.

A more elaborate method is:

Clean the copper thoroughly with a strong soda solution (4 to 6 ounces per gallon of hot water) or with fine pumice and kerosene and then wipe it off with gasoline.

Apply with a brush a solution of 1 oz. of liver of sulphur in one gallon of lukewarm water.

After the desired color has been obtained wash the solution off with water.

The above formula should be first tried out on a small piece of copper. If the color obtained the first time is not satisfactory it may be advisable to give a second coating of the solution.

2. Green: Verdigris; Copper Patina.

Clean the copper thoroughly with a strong solution (4 to 6 ounces per gallon) of soda in hot water. Wash this off with clean hot water.

Apply with a brush a solution of ½ lb. of salt to 2 gals. of hot water. Let stand for one day and then sprinkle the surface with clean water.

It is absolutely necessary for good results that all the grease and oil of the manufacturing process be removed from the copper. The strong soda solution will do this. Uniform finish will not be obtained unless the copper is thoroughly cleaned.

Copper left to the action of the atmosphere will eventually turn green, the color of copper carbonate. It first darkens, then becomes a dull black (the oxide); finally the oxide changes to the carbonate which is the well-known patina of copper. This carbonate is a protective coating and should not be removed.

PAINTING COPPER

It is difficult to obtain a good bond between paint and copper. This is due to the grease and oil of the manufacturing process which is rolled into the fine pores in the surface of the sheets.

Paint applied directly to untreated copper will not stand for any length of time, particularly when exposed to the weather. The surface must be thoroughly cleaned and roughened before the paint will adhere.

This may be accomplished by washing the copper with a solution of 4 ozs. of copper sulphate in one-half gallon of luke warm water in a glass or earthern vessel, to which is added one-eighth ounce of nitric acid. If the surface is still very smooth, additional roughening must be done by abrasives.

Before painting, the surface must be carefully washed with clean water to remove the last trace of the solution and the paint must not be applied until the surface is thoroughly dry.

Three coats of paint will give the best results. The first coat should be composed of 15 pounds of red lead to one gallon of raw linseed oil with not more than ½ pint of oil dryer. The last two coats should be composed of 15 pounds of white lead to 1 gallon of raw linseed oil with not more than 5 per cent. of oil dryer and the necessary color.

PROPORTIONING GUTTERS AND LEADERS

The chief consideration in designing gutters and leaders is to conduct the water running off a roof quickly and easily away. To do this it is essential that, (1) the gutter be large enough to conduct all the water to the outlet; (2) the outlet be large enough to accelerate the velocity of the water in the gutter when it enters the outlet.

It is obvious that more water will drop through

a vertical pipe than will flow in a horizontal trough of equal area. Therefore it might appear that the leader could well be much smaller than the gutter and take care of all the water flowing into a gutter. The problem would resolve itself into one of hydraulics were it not for practical considerations.

It is also good practice to make the leader the same size in its descending length as at the outlet, so that there may be no stoppage due to leaves or ice. These factors enter so acutely into the design that the problem becomes one more practical than hydraulic, although the principles of hydraulics enter into it.

Practice for leader sizes varies with different authorities from 75 to 250 square feet of roof surface to each square inch of leader cross section. This variation is due, in part, to varying conditions of rainfall in different parts of the country. The maximum rate varies from 4.5 to 8.7 inches per hour. In short periods during thunder showers even heavier falls have been recorded.

It seems reasonable to base computations on a rate of 8 inches per hour. At this rate of fall the water to be handled for 1,000 square feet of roof surface is 666.7 cubic feet per hour, or 0.185 cubic feet per second, or 83 gallons per minute.

Gutters and leaders large enough to carry away this amount of water will insure a satisfactory system.

The first step in designing such a system is location of the leaders. **Seventy-five feet is the maximum spacing recommended.** This done, the area drained per leader is computed and the area of the leaders determined. **A safe rule is 150 sq. ft. of roof area to 1 sq. in. of leader area.**

An application of this rule gives the following tabulation:

	Area in sq. in.	Leader size	Sq.ft. roof area drained
Plain Round	7.07	3″	1060
	12.57	4″	1885
	19.63	5″	2945
	28.27	6″	4240
Corrugated Round	5.94	3″	890
	11.04	4″	1660
	17.72	5″	2660
	25.97	6″	3895
Polygon Octagonal	6.36	3″	955
	11.30	4″	1695
	17.65	5″	2650
	25.40	6″	3810
Square Corrugated	3.80	1¾″ x 2¼″ (2″)	570
	7.73	2⅜″ x 3¼″ (3″)	1160
	11.70	2¾″ x 4¼″ (4″)	1755
	18.75	3¾″ x 5″ (5″)	2820
Plain Rectangular	3.94	1¾″ x 2¼″	590
	6.00	2″ x 3″	900
	8.00	2″ x 4″	1200
	12.00	3″ x 4″	1800
	20.00	4″ x 5″	3000
	24.00	4″ x 6″	3600

The above figures can be reduced or increased to meet local conditions where the intensity of rainfall is definitely known.

There are practical considerations to the problem. No leader should be less than 3 inches where there is a possibility of leaves, etc., passing into it. Two-inch leaders are often used for porches and decks, and are permissible if precaution is taken to safeguard the gutter outlet against stoppage.

The size of gutters depends upon

1. **The number and spacing of the outlets.**
   The gutter acts as a reservoir or collecting channel which holds the water and carries it to the outlet. The slope of the gutter determines the flow toward the outlets.
2. **The slope of the roof.**
   A steep roof carries the water to the gutter faster than a flat one does.
3. **The style of gutter used.**
   Some gutters are not effective for their full depth and width. In proportioning gutters proper consideration of the available area is essential.

The best type of gutter has the minimum depth equal to half and the maximum depth not exceeding three-quarters the width. Thus the width becomes the deciding factor in proportioning its size. There is no reason for a gutter deeper than three-quarters of the width except for ornamental purposes.

Assuming that this proportion is observed the gutter may be referred to by its width only.

A gutter smaller than four inches wide is to be avoided. In common practice 4-inch gutters are seldom used for they are difficult to solder and increase the labor cost. The gutter may be the same size as the leader it serves, but, of course, can not be smaller.

Half-round gutters are most economical in material and insure a proper proportioning of width and depth.

Safe rules for determining the size of gutters are:

1. If spacing of leaders is 50 feet or less, use a gutter the same size as the leader, **but not less than 4-inch.**

2. If spacing of leaders is more than 50 feet, add 1 inch to the leader diameter for every 20 feet (or fraction) additional spacing on peaked roofs.

3. For flat roofs add 1 inch to the leader size for every 30 additional feet of gutter length.

Examples:

1. A 40-foot gutter serves a 3-inch leader. The gutter should be 4-inch.

2. A 75-foot gutter serves a 4-inch leader on a steep roof. The gutter size is 6-inch.

3. A 75-foot gutter serves a 4-inch leader on a flat roof. The gutter size is 5-inch.

For ordinary residence construction 3 or 4-inch round and 2″ x 3″ or 2″ x 4″ rectangular leaders will generally suffice. Five-inch half round gutters meet practically every requirement.

In large building design, such as factories and offices, careful attention should be given to the design of the roof drainage-system.

A safe system to follow in mill building design is that of the American Bridge Company. Their specifications provide as follows:

Span of Roof	Gutters	Leaders
Up to 50 feet	6 inches	4 inch every 40 feet
50 to 70 feet	7 inches	5 inch every 40 feet
70 to 100 feet	8 inches	5 inch every 40 feet

Hanging gutters shall slope 1 inch in every sixteen feet.

Progressive Steps in Designing Gutters and Leaders:

1. Locate position of leaders.
2. Compute area of roof drained by each leader.
3. Compute size of leader by dividing roof area by 150.
4. Compute size of gutters to supply leaders.

Notes

1. Round leaders should not be less than 3 inches in diameter.
2. Rectangular leaders should not be smaller than $1\frac{3}{4}'' \times 2\frac{1}{4}''$. (This is commonly called "2" square inches).
3. Gutters should not be less than 4 inches wide.
4. Gutters should have a fall of not less than 1 inch in 16 feet.
5. Scuppers should be provided for all roofs with a parapet wall built around them. This precaution prevents an overloading of the roof due to stoppage of the outlet.
6. All outlets should be provided with screens or strainers.

PRICE ESTIMATES

[This Association, being engaged solely in research and educational work, and being in no sense a selling organization, does not quote prices.]

In the tables and text of this handbook, where a base price, or list price, is set out, this price is derived from an average selling price for copper and cost of manufacture and distribution. Market conditions raising or lowering the selling price of copper, or affecting to a very appreciable extent the cost of manufacture, would raise or lower this price. The tables of extras are derived from printed lists in public use at the time of publication.

In using this handbook for the purposes of estimating, the base price, list price, table of extras and discount on extras, at the time of estimate, should be obtained, so far as necessary, from a reliable manufacturer or dealer. Any unusual variations from the method of computation set forth herein should be investigated by the person making the estimate.

In using the tables of list prices it should be borne in mind that these prices are subject to discount. When making up cost data the market discounts from list should be obtained.

ESTIMATING THE COST OF COPPER SHEETS

The difference in the cost of copper sheets is determined by (1) the thickness, (2) width, and (3) length. Sheets can be obtained of any desired dimension as shown in Table III. Table IV gives the extras added to the prices in Table III for various items such as tinning and polishing. It will be noted that hard (C. T.) sheets carry an extra.

Examples of the method of computing follow:

I. What is the price of 16 oz. soft (R.T.) sheet copper 30″ x 96″?

The base price of soft (R. T.) Copper sheet is assumed at 23¾ cents per lb. and there is a 10% discount on extras.

From Table III the extra for sheet *over* 28″ *to and including* 36″ *in width* and *over* 72″ *to* 96″ in length is 2½ cents per lb. Deducting 10% makes this figure 2.25 cents. Adding to the base we get

Base. . . 23.75 cents
Extras. . 2.25 "
Total. . . 26 cents per lb. (or sq. ft.)

II. What is the price per sheet of hard (C .T.) 18 oz. copper 14″ x 20″, tinned 1″ wid e on the edges?

The extra for 18 oz. soft (R.T.) sheet 14″ x 20″, is 2.5 cents per lb. (Table III.) The extra for hard (C. T.) sheets is 3.0 cents per lb. (Table IV.) For tinning hard (C. T.) sheets there is an additional extra of ½ cent per lb. (Table IV.)

	2.5 cents
	3.0 "
	0.5 "
	6.0 cents
Less 10% discount. .	0.6
Net extras.	5.4 cents per lb.

The base price for copper sheets is assumed at 23.75 cents per lb. Price for hard (C.T.) sheets, 14″ x 20″, is 23.75+5.4=29.15 cents per lb.

A sheet 14″ x 20″ contains 1.94 sq. ft. At 18 ozs. per sq. ft. the sheet weighs 2.18 lbs.

Tinning is figured as so much per square foot of sheet tinned without regard to the actual area tinned.

2.18 x 29.15 .... 63.55 cents
Tinning 1.94 sq. ft. at
6 cents per sq. ft .... 11.64 "
Cost per sheet .... 75.19 cents

Cost per lb. ——— $75.19 \div 2.18 = 34.49$ cents.

TABLE IV

(Price List of Extras over Base)

Sheet-Copper Extras

Cold-rolling—Hard (C. T.) sheets—

14 oz. per sq. ft. and heavier .... 3 cents per lb.
Lighter than 14 oz. .... 6 cents per lb.

Tinned Hard (C.T.) Sheets require an additional rolling after being Tinned and carry an extra **over above advances** of ½c per lb.

Tinning—[Net extras.]

	96 in. and less	Over 96 in.
20 in. wide and under	6c. per sq. ft.	7c. per sq. ft.
Over 20 in. to 48 in. incl.	7c. " " "	8c. " " "
Over 48 in.	8c. " " "	9c. " " "

Tinned both sides double the above prices.

For tinning the edges of sheets, one or both sides, price shall be the same as for tinning all of one side of the specified sheet. For orders of less than 100 lbs. where case or crate is necessary, charge will be made at seller's discretion to cover cost of same.

The process of manufacture is such that a slight variation in weight is to be expected. In estimating it is usual to allow 3% extra for this overweight. After the net amount of copper needed is determined this percentage is added and the cost figured.

STRIP COPPER

Strip copper is coming more and more into use for flashings. It has several advantages; some of which are its cheaper price; its workability. It can be purchased in small quantities at a cost somewhat lower than sheets, and there is practically no waste. It is made in all widths up to 20 inches.

The process of manufacture is such that straight edges are obtained. Heretofore, this has been an objection to long sheets of copper.

Strip copper is readily obtainable in rolls about 75 ft. long. It is also made by some mills in convenient lengths up to 10 feet.

The accompanying Table V gives the sizes and extras over base price for different widths, as well as prices for cutting into lengths.

It is generally best to cut the copper to length on the job, for the actual conditions can best determine the lengths needed.

TABLE V

Sheet Copper in Rolls

LIST ADVANCES IN CENTS PER POUND OVER BASE PRICE

B. & S. Ga.	Decimal Equivalent in Inches	Nearest Equivalent Weight in Ounces per Sq. Ft.	Over 2 in. to 8 in. Incl.	Over 8 in. to 12 in. Incl.	Over 12 in. to 14 in. Incl.	Over 14 in. to 16 in. Incl.	Over 16 in. to 18 in. Incl.	Over 18 in. to 20 in. Incl.
20	.0319	24	Base	½	2	3	5	7
21	.0284	20	½	1	2½	4	6	8
22	.0253	18	½	1	2½	4	6	8
23	.0225	16	1	1½	3	5	7	9
24	.0201	15	1	1½	3	5	7	9
25	.0179	14-13	1½	2	4	6	8	10
26	.0159	12	1½	2	4	6	8	10
27	.0142	11-10	2	3	5	7	9	11
28	.0126	9	2	3	5	7	9	11
29	.0112	8	2½	4	6	8	10	12
30	.0100	7	2½	4	6	8	10	12
31	.0089	......	3	5	7	9	...	...
32	.0079	6	4	6	8	10	...	...
33	.0071	......	5	7	9	...	...	...
34	.0063	......	8	10	12	...	...	...
35	.0056	......	11	14	...	...	...	...
36	.0050	......	14	18	...	...	...	...

Sizes of Roll Copper between gages noted above take price of nearest gage.

LIST EXTRAS FOR SLITTING AND CUTTING TO UNIFORM SPECIFIC LENGTHS

For CUTTING ROLL COPPER, over 2 inches but not more than 10 inches wide, to UNIFORM SPECIFIC LENGTHS, NOT SQUARED add the following extras to regular list advances.

Shorter than 12 in. Special Prices (not less than 1c.)	1 Ft. up to (but not including) 4 Ft.	4 Ft. up to (but not including) 6 Ft.	6 Ft. up to (but not including) 8 Ft.	8 Ft. up to (but not including) 10 Ft.	10 Ft. and over Special Prices (not less than 6c.)
	1c.	2c.	4c.	6c.	

All roll copper cut to length and SQUARED, regardless of width and length, TAKES PRICE OF SHEET COPPER.

TABLE III

HOT ROLLED OR SOFT (ROOFING TEMPER) SHEET COPPER

IN FLAT SHEETS

LIST EXTRAS IN CENTS PER POUND OVER BASE PRICE

Prices are for 100 pounds or more per item in one order

THICKNESS OR WEIGHT PER SQ. FT. IN OUNCES		64 oz. up to ½"	48 up to 64 oz.	32 up to 48 oz.	24 up to 32 oz.	20 up to 24 oz.	18 up to 20 oz.	16 up to 18 oz.	15 oz.	14 oz.	13 oz.	12 oz.	11 oz.	10 oz.	9 oz.	8 oz.
WIDTHS	LENGTHS	ADVANCES IN CENTS PER POUND OVER BASE PRICES														
6" to 10" both included	6" to 24" both included		BA	SE		2	2½	3	3½	5	7	9	11½	14	17	21
	Over 24" to 60"		PRI	CE		1	1½	2	2½	4	5	7	8½	10	12	14
	Over 60" to 96"		APP	LIES		1	1½	2	2½	4½	5½	7½	9½	11	13	16
	Over 96" to 120"		O	N		2	2½	3	3½	5	6½	8	11	12½	15	18
	Over 120" to 200"		SIZ	ES		3	3½	4	4½	5½	7½	9½	13	15	18	21
Over 10" to and including 20"	Any Length up to 24"		INS	IDE	1	2	2½	3	3½	5	6½	8	9½	12	15	18
	Over 24" to 60		O	F	½	1	1½	2	2½	3	4	5	7	9	12	15
	Over 60" to 96"		TH	IS	½	1	1½	2	2½	3½	4½	5½	8	10½	14	17
	Over 96" to 120"		HE	AVY	1	1½	2	2½	3	4	5	6	9	12	16	19
	Over 120" to 200"		BLA	CK	1½	2½	3	3½	4	5	6	8	11	14	18	22
Over 20" to and including 28"	Any Length up to 60"	LI	NE	2	3	3½	4	4½	5	6½	9	12½	15	18	21	25
	Over 60" to 96"			1	1½	2	2½	3	4	5	6½	8½	11	14	17	21
	Over 96" to 120"			1½	2	2½	3	3½	4½	7	9	11½	13½	.....	.....	.....
	Over 120" to 200"			2	3	4	5	6	7	10	13	16	19	.....	.....	.....
Over 28" to and including 36"	Any Length up to 72"		1	2	2½	3	3½	4	5	6½	9	12	15	18	21	24
	Over 72" to 96"		½	½	1	1½	2	2½	3	4	6	8½	11	14	.....	.....
	Over 96" to 120"		½	1	1½	2	2½	3	4	6	9	12	15	.....	.....	.....
	Over 120" to 200"		1	2	3	4	5	6	8	11	14	17	20	.....	.....	.....
Over 36" to and including 48"	Any Length up to 72"		1	2	3	4	5	6	9	12	16	20	24	28	.....	.....
	Over 72" to 96"		½	1	2	3	4	5	7½	11	15	19	23	27	.....	.....
	Over 96" to 120"		½	1½	2½	3½	4½	6	9	13	17	22	.....	.....	.....	.....
	Over 120" to 200"		1	2	3½	5	7	9	12	16	21	26	.....	.....	.....	.....
Over 48" to and ncluding 60"	Any Length up to 72"	1	2½	4½	6½	8½	10½	13	16	20	.....	.....	.....	.....	.....	.....
	Over 72" to 96"	½	1	3	5	7	9	12	15	19	.....	.....	.....	.....	.....	.....
	Over 96" to 120"	½	1½	4	5½	7½	9½	11½	.....	.....	.....	.....	.....	.....	.....	.....
	Over 120" to 200"	1	3	5	7	10	13	16	.....	.....	.....	.....	.....	.....	.....	.....
Over 60" to and including 72"	Any Length up to 72"	2	4	6	8½	12	15½	18	.....	.....	.....	.....	.....	.....	.....	.....
	Over 72" to 96"	1½	3	5	7½	11	14½	20	.....	.....	.....	.....	.....	.....	.....	.....
	Over 96" to 120"	1½	3½	6	9	12	15½	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Over 120" to 200"	2	4	7	10	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Over 72" to and including 108"	Any Length up to 96"	3	6	9	12	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Over 96" to 120"	2	5	8	11	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Over 120" to 200"	3½	7	10	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

SHEETS LIGHTER THAN 8 OZ.—SPECIAL

THE LONGEST DIMENSION OF ANY SHEET SHALL BE CONSIDERED AS ITS LENGTH

SHEETS OVER ½ INCH THICK OR OVER 200 INCHES LONG—SPECIAL

GUTTERS, LEADERS AND ACCESSORIES

Sizes, Shapes, List Prices, Etc.

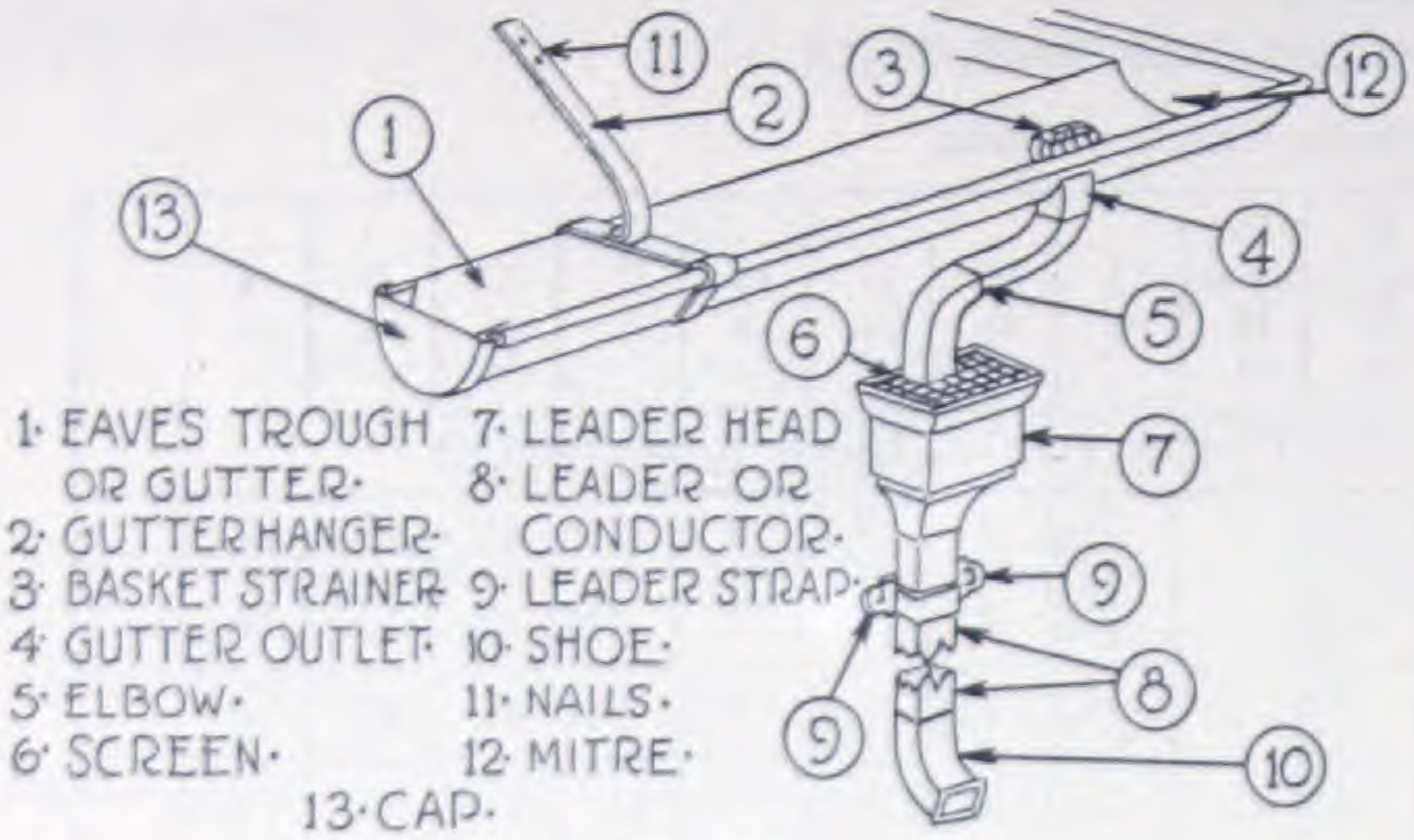


Fig. 84

In Fig. 84 are shown the various parts of gutters, leaders and accessories as generally made up and stocked by manufacturers. While there is some difference in nomenclature throughout the country, the manufacturers and trade in general use the designations given.

HALF-ROUND EAVES TROUGH

Molded gutters, including half-round, are made in several designs. The most commonly used is the Single Bead, half-round Eaves Trough illustrated in Fig. 85–86.

Fig. 85
S.B.Lap Joint

Fig. 86
S.B. Slip Joint

TABLE VI

List Prices Per Foot of Single-Bead Eaves Trough

Lap Joint

Size, Inches.....	3	4	5	6	7	8	9	10
16 ozs.........	$0.26	.32	.36	.44	.54	.63	.80	.95
Slip Joint								
Size, Inches.....	3	4	5	6	7	8	9	10
16 ozs.........	$0.29	.35	.39	.47	.57	.66	.83	.98

This type of gutter is stocked throughout the country, and is carried in sizes up to 6 inch by practically every sheet metal contractor. Sizes above 6 inch are not in common use, as buildings requiring gutters of a larger size usually have them built-in or made a part of the cornice. Sizes up to 10 inch may be had and are stocked in the warehouses of large distributing companies in the principal cities.

TABLE VII

List Prices Per Foot of Double-Bead Eaves Trough

Lap Joint

Size, Inches.....	3	4	5	6	7	8	9	10
16 ozs.........	$0.32	.40	.45	.55	.64	.75	.92	1.07
Slip Joint								
Size, Inches.....	3	4	5	6	7	8	9	10
16 ozs.........	$0.35	.43	.48	.58	.67	.78	.95	1.10

Fig. 87
Double-Bead Lap Joint

Fig. 87 shows the Double-Bead Eaves Trough. This, as may be noted from its contour, is somewhat stiffer than the Single-Bead. On account of this stiffness it is possible to place the hangers slightly farther apart than when the Single-Bead is used. However, it is much more difficult to erect, as the inside bead makes it difficult to line it against the roof edge, and to secure the hanger. It also costs more than the Single-Bead. That the Single-Bead is in every respect satisfactory is indicated by the fact that there is so little call for the Double-Bead that it is not stocked and has to be made up to order.

Half-round Eaves Trough is made in both lap- and slip-joint style (Figs. 85 and 86). The slip joints are used to provide expansion and contraction in long runs of gutters. They are set about every five lengths or fifty feet apart, the joints between being lapped and soldered. The slip joint is not soldered. In some localities the practice is to lap the lengths about three inches and use no solder or slip joints. This practice is satisfactory where there is considerable slope to the gutter and where there is no danger of leaves, etc., stopping the flow toward the outlet. It is hardly necessary to state that all joints in gutters should be made in the direction of the flow.

MOLDED COPPER GUTTERS

TABLE VIII

Sizes

Style C

5" wide, 3½" deep, 12" girth
6" " 4¼" " 14" "
7" " 4½" " 16" "

Fig. 88

Fig. 89

Style D
6″ wide, 4″ deep, 15″ girth
7″ " 5″ " 18″ "
8″ " 5¾″ " 20″ "

Fig. 90

Style E
6″ wide, 4½″ deep, 15″ girth
7″ " 5½″ " 18″ "
8″ " 7″ " 22″ "

Fig. 91

Style F
6″ wide, 5½″ deep, 18″ girth
7″ " 5¾″ " 20″ "
8″ " 6″ " 22″ "

Fig. 92

Style G
6″ wide, 5½″ deep, 18″ girth
7″ " 6½″ " 20″ "
8″ " 7 ″ " 22″ "

Fig. 93

Style H
6″ wide, 4 ″ deep, 14″ girth
7″ " 4¾″ " 16″ "
8″ " 5½″ " 18″ "

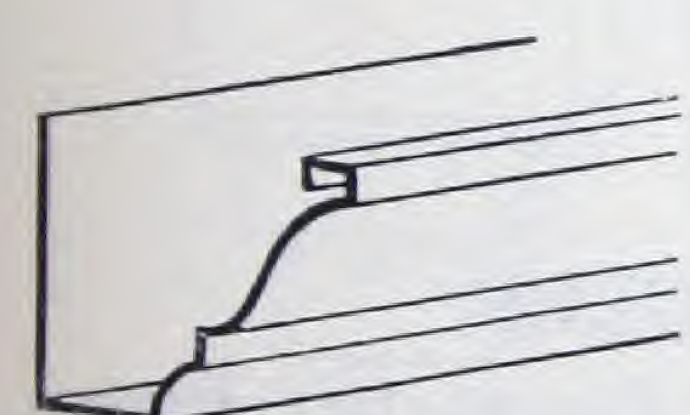


Fig. 94

Style J
6″ wide, 5¾″ deep, 18″ girth
7″ " 6½″ " 20″ "
9″ " 8″ " 24″ "

Molded gutters of a quite different style are shown in Figs. 88 to 94. As the popularity of these does not warrant their being stocked, they are usually made up to order and prices may be had on application only. A study of Table VIII indicates why these styles do not sell as well as the Single-Bead Eaves Trough. It is apparent that Style C, for instance, simple in contour as it is, has more copper in it than has a similar sized half-round shape. This adds to the cost.

A 5-inch half-round Single-Bead Eaves Trough has a girth of 10 inches. Style C gutter, 5 inches wide, has a girth of 12 inches, 20% more. A 6 inch half-round Single Bead Eaves Trough has a girth of 12¼ inches. Styles C and H gutters have a 14 inch girth; style D, 15 inch; styles G and J, 18 inch. The increase in the amount of copper varies from 14 to 46%.

END PIECES, CAPS AND OUTLETS

Fig. 96
Outlet

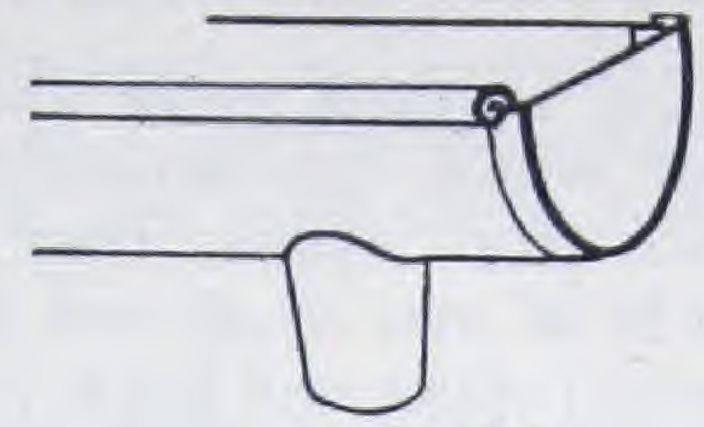


Fig. 97
End Piece, Cap and Outlet

Fig. 98
Cap

TABLE X

List Prices Per Piece of End Pieces, Caps and Outlets

Size	16 oz.					
	3″	4″	5″	6″	7″	8″
Ends With Outlets...	$0.95	1.05	1.10	1.15	1.30	1.50
End Caps Only......	.40	.45	.48	.50	.60	.70
Outlets Only......	.40	.45	.48	.50	.60	.70

Figs. 96 to 98 show the usual accessories for half-round Eaves Trough which are carried in stock or can be quickly supplied. It is recommended that these pieces be used wherever necessary as they are factory made and are generally of stronger construction than those made in the field.

MITRES

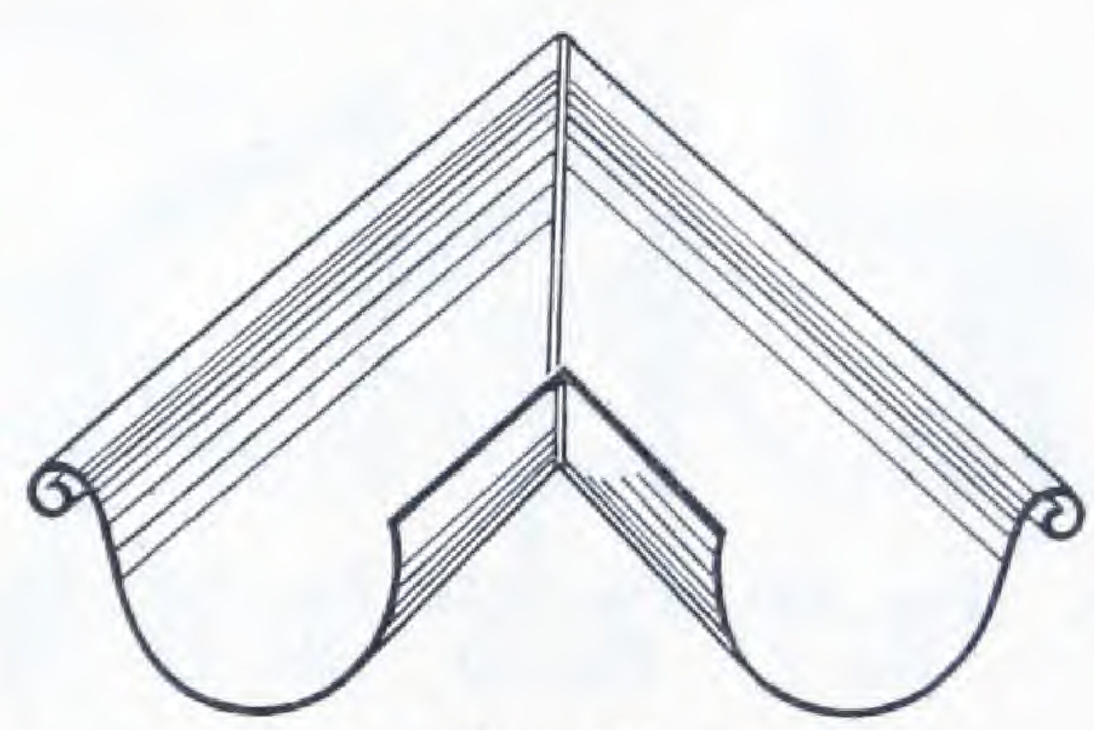


Fig. 98

TABLE IX

List Prices Per Piece of Single-Bead Half-Round Gutter Mitre

Size	16 oz.	
	Lap Joint	Slip Joint
3″	$0.85	$0.95
4″	0.95	1.05
5″	1.00	1.10
6″	1.05	1.15
7″	1.15	1.30
8″	1.35	1.50

For double-bead Mitres add 25 cents to prices for single-bead. In ordering state whether "Inside" or "Outside" Mitres are wanted, and if Slip Joint, whether "Rights" or "Lefts." Otherwise half of each kind will be sent.

GUTTER HANGERS

There are many kinds of gutter hangers on the market, most of which are satisfactory for the special condition for which they are made. Hangers are made of cast brass and bronze (Figs. 99 to 103), of strap copper and brass (Figs. 104 and 105) and of heavy copper wire (Fig. 106).

The cast type are the most expensive. As they are made in two pieces (a "shank" and a "circle") it is possible to set the shanks when the building is being erected and to hang the gutters after the painting is done, thus avoiding the chance of damage to the gutters by the painters' scaffolding and ladders.

Strap hangers cost less than the cast, and are in every way satisfactory. They are simple to apply and lend themselves to almost every type of eave.

Wire hangers have to recommend them, cheapness and ease of application. They are not as strong as are the other two types, and for that reason must be placed closer together.

The spacing of cast or strap hangers should not exceed 36 inches. Wire hangers should not be more than 24 inches apart. Good practice for these is 30 inches and 18 inches respectively.

Fig. 99 No. 6 · Fig. 100 No. 7 · Fig. 101 No. 10 · Fig. 102 No. 11 · Fig. 103 No. 12

TABLE XI

LIST PRICE PER 100 PIECES OF BRASS HANGERS, SHANKS AND CIRCLES

Shanks		Circles		
		Size Inch	Single Bead	Double Bead
		3	$12.50	$17.00
No. 6	$25.00	4	18.00	20.00
No. 7	16.00	5	21.00	24.00
No. 10	22.00	6	28.00	28.00
No. 11	22.00	7	38.00	38.00
No. 12	28.00	8	44.00	44.00

In estimating cast hangers be sure to include the proper size circle with the type of Shank selected.

Fig. 104

Fig. 105

TABLE XII

APPROXIMATE PRICE PER GROSS OF STRAP HANGERS

Size, Inches	Gross Lots	Less Than Gross
4	$30.00	$35.00
5	31.00	36.00
6	33.00	38.00

WIRE HANGERS

Fig. 106

WIRE HANGERS

APPROXIMATE PRICE PER PIECE—100 PIECES OR LESS

4", 5" or 6", ... 15 cents

Wire Hangers

LEADERS

As may be seen in Figs. 107 to 110 leaders or conductors are made in four different shapes. Special designs may also be had upon application. Plain round leaders are not generally stocked by manufacturers and jobbers. They are not generally used because, it is stated, they do not resist freezing as well as do the corrugated ones. Moreover the latter are more pleasing in appearance when in place than are the plain ones.

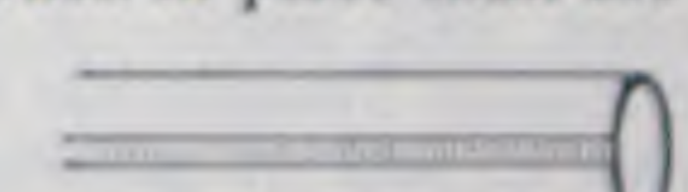


Fig. 107
Plain Round Leader

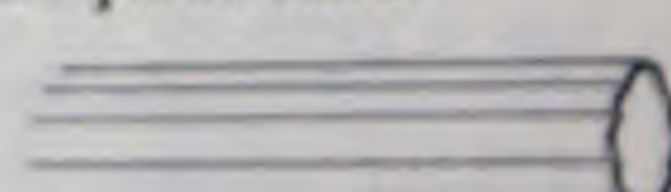


Fig. 108
Corrugated Round Leader

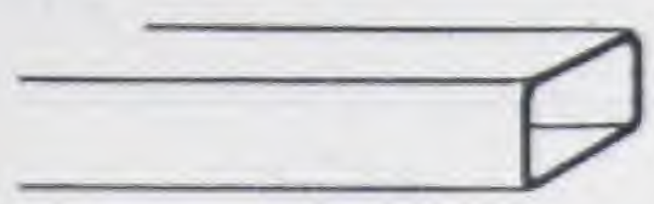
TABLE XIII

List Price Per Lineal Foot of Round, Plain and Corrugated Leaders

Diameter	2"	3"	4"	5"	6"
Weight—16 ozs........	$0.30	$0.36	$0.51	$0.69	$0.90

16 oz. leaders furnished in 10 foot lengths.

Square Corrugated Leader
Fig. 109



Plain Rectangular Leader
Fig. 110

TABLE XIV

List Price Per Lineal Foot of Square Corrugated Copper Leader

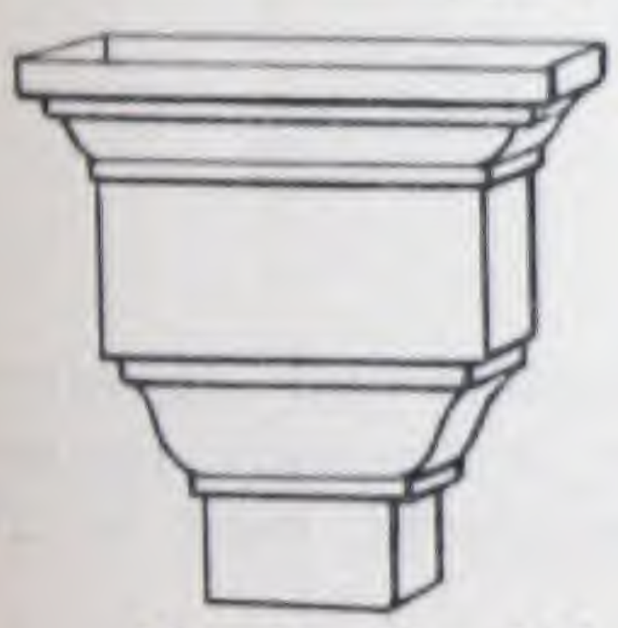
Size	2"	3"	4"	5"
Weight	(1¾"x2¼")	(2⅜"x3¼")	(2¾"x4¼")	(3¾"x5")
16 ozs	$0.31	$0.40	$0.53	$0.75

Figures in parenthesis show actual size.

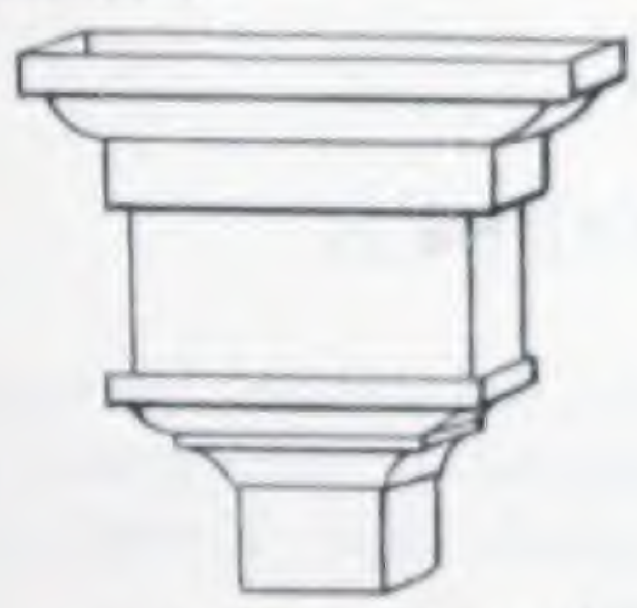
LEADER HEADS AND STRAPS

Figs. 111 to 117 illustrate ornamental leader heads and straps of stock design. Special designs can be quickly made up. The number required largely controls the cost of manufacture.

LEADER HEADS



No. 5—Fig. 111



No. 7—Fig. 112

Fig. 113

Fig. 114

Fig. 115

No. 14—Fig. 116

Figs. 114, 115 and 116 are usually carried in stock.

The number required largely controls the cost of manufacture. Special designs can be made up to order from the architect's dimensioned drawings.

ORNAMENTAL LEADER STRAPS

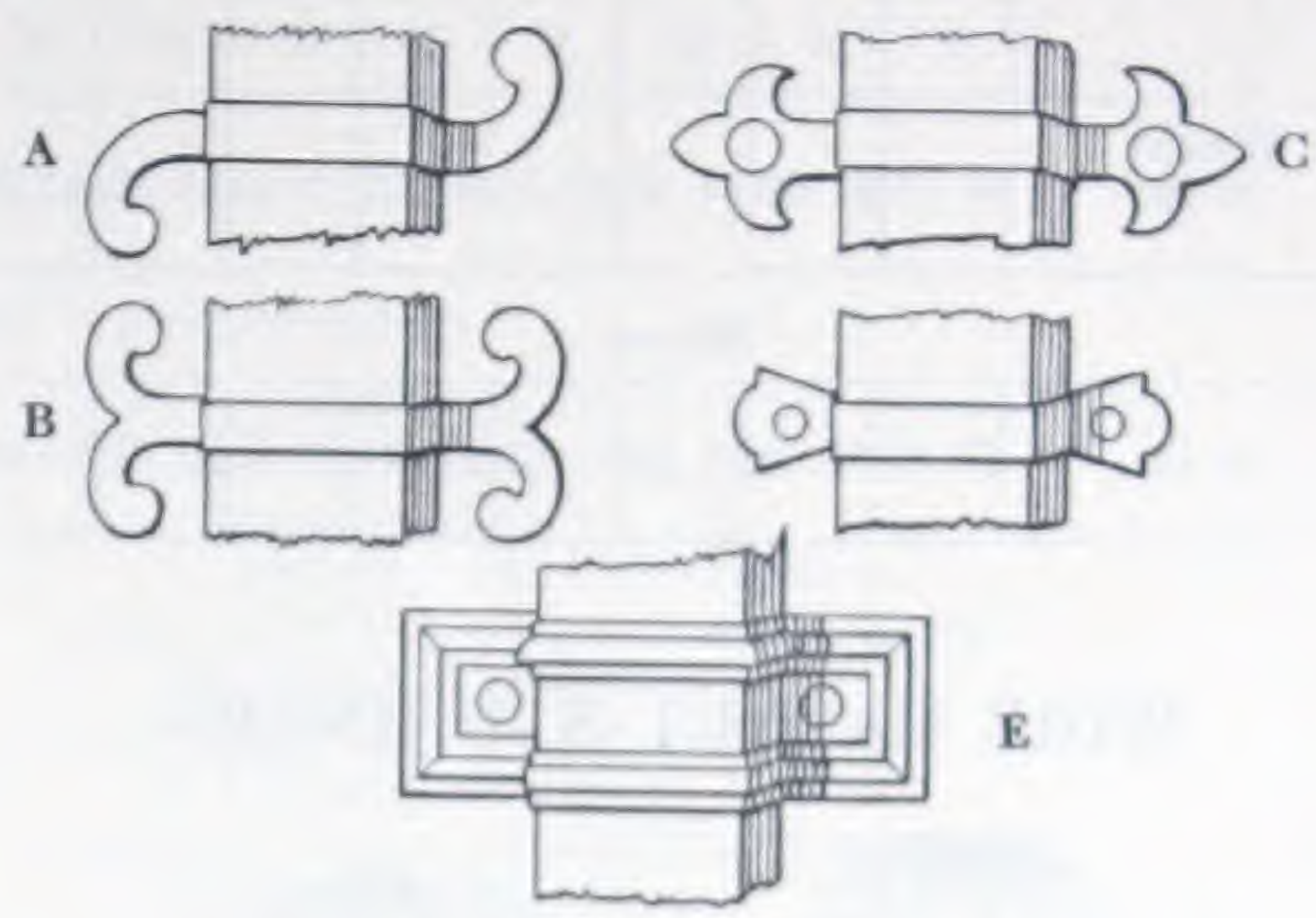


Fig. 117

These styles are not carried generally in stock but can be quickly made up to order.

BRASS LEADER HOOKS

Fig. 118

Fig. 119

Fig. 120

Leader hooks and ornamental straps should not be spaced more than 6 feet apart.

COPPER ELBOWS AND SHOES

Fig. 121
Elbow

Fig. 122
Style A
Elbow

Fig. 123
Shoe

Stock leader accessories, such as elbows, shoes, and hooks are illustrated in Figs. 118 to 123. They are made in many styles and shapes to fit every condition encountered in building.

TABLE XV

List Prices Per Piece of Copper Elbows and Shoes

Elbows

Size	Round—Plain or Corrugated				Square—Corrugated			
	2"	3"	4"	5"	2"	3"	4"	5"
Weight 16 oz.	$0.75	$1.00	$1.50	$2.25	$0.90	$1.20	$1.80	$2.75
Shoes								
16 oz.	$0.85	$1.10	$1.65	$2.50	$1.05	$1.35	$2.00	$3.00

WIRE BASKET STRAINERS

Fig. 124

Fig. 125

Wire basket strainers of stock design and as generally carried by jobbers and sheet metal contractors are shown in Figs. 124 and 125. Strainers of heavier design and wire can be made up quickly to specification. Every outlet should be provided with strainers. Especially is this essential when the leaders are small or have any elbows, etc., where leaves are likely to stick and clog the leader.

TABLE XVI

List Price Per Dozen of Copper Wire Basket Strainers

Round			Square		
Size of Outlet	Size of Wire	Per Dozen	Size of Outlet	Size of Wire	Per Dozen
2"	17	$1.80	2" x 2"	17	$3.20
3"	17	2.90	2" x 3"	17	4.00
4"	16	4.20	3" x 3"	17	6.40
5"	15	7.20	3" x 4"	16	8.00
6"	15	8.25	3" x 5"	16	8.40
			4" x 4"	16	9.00
			4" x 5"	15	10.00
			4" x 6"	15	11.00

These strainers may be had in the round shape made with as heavy as No. 10 wire. In the square shape the heaviest wire is No. 14.

14-OUNCE COPPER

Copper gutters and leaders are also made of 14-ounce material. There is so little call for them, however, that they are not stocked, and are made to order by most manufacturers. The price difference between 14-ounce and 16-ounce material is not great and it is strongly recommended that 16-ounce materials be used in all cases.

STOCK PACKAGES

Practice in making up stock packages varies somewhat with different mills. Because of the expense of crating sheets for shipment the mills make up packages as large as can be conveniently handled.

Sheets are always packed flat in rectangular crates weighing between 500 and 600 pounds.

Strip, or roll, copper, is packed either in long crates (6 to 10 feet) weighing up to 500 pounds, (about 50 strips to the box), or in rolls of about 75 feet, four or five rolls to the crate.

Eaves trough, leaders, and molded gutters are shipped in crates of 25 lengths, 10 feet long. Cornices, ridge rolls and similar shapes are shipped the same way.

Accessories such as caps and mitres, elbows and shoes, hangers, leader heads, leader straps, wire basket strainers and snow guards are shipped in cartons, in lots of fifties, hundreds, or grosses, depending upon the size.

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